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EDITORIAL

Cocoa in Malaya.

Following Professor Cheesman's visit to this country early in 1948 and his subsequent report considerable interest has been aroused in the possible development of cocoa growing in Malaya. From recent articles which have appeared in the Press and from correspondence which has been received by the Department of Agriculture it is evident that estates are interested not only in cocoa as a sole crop but particularly in the possibilities of mixed cocoa and rubber cultivation. The answers to both these questions can be determined by practical experiment alone. The answers are, however, of great interest to the Department because they may eventually have considerable influence not only on estate practice but also on the general pattern of small-holding agriculture. At the moment it is clearly too early to recommend cocoa growing to small-holders. The first phase in the development of any new crop is experimental, and until this phase is successfully completed it is inadvisable to encourage planting by the small-holder which would involve in this case not only risk of failure but also the loss of existing rubber or other cash crops which had been cut out for planting purposes. The experiments now in progress throughout the country will provide information which can be utilized for the benefit of all growers, both estates and small-holders.

Leaving aside such considerations as staff and finance the immediate problem which limits the amount of experimentation which may be undertaken at the present moment in Malaya is the available supply of planting material. At first sight the solution would appear to be bulk importation of planting material from other countries such as the West Indies, West Africa, Java and Ceylon. There are, however, very serious objections to this step. One of the reasons why there is such a world demand for cocoa is that yields in West Africa and in the West Indies have been declining seriously for the past few years owing to the incidence of two diseases, namely " swollen shoot " in West Africa and " Witches' Broom " in the West Indies. In Java, yields have been affected by the incidence of a cocoa moth, and in Ceylon, cocoa is subject to a pod-rot, canker, and a pod-boring insect. One of the great advantages with which Malaya could start to build up a cocoa industry is that at the moment there appear to be no serious diseases of cocoa in the country. It is imperative, therefore, that

as far as possible all steps should be taken to ensure that this happy state of affairs persists. Consequently it has been found necessary to prohibit completely the importation of large quantities of planting material, and to allow only very limited importations of selected material under adequate quarantine precautions. Recently a site for a suitable isolation nursery has been chosen on an island near Singapore and it is hoped that within a few months arrangements will be completed whereby small importations of selected material to this nursery may be allowed.

The difficulties attendant upon importation were realized at an early stage following Professor Cheesman's visit, and in order to commence field experiments as soon as possible it was decided early in 1948 that the maximum use should be made of any existing planting material then in Malaya.

There are two types of cocoa at present growing in Malaya known as Criollo type and Trinitario type. The Criollo type is easily distinguishable by the white colour of the freshly cut beans. The commercial demand for Criollo is very limited and in general in other parts of the world it is being found more difficult to grow, more susceptible to disease, and of lower yielding capacity than the Trinitario type. The Criollo type is found growing in Malaya in scattered kampongs throughout the country.

The Trinitario type cocoa, which is the " fine " cocoa in commercial demand, is distinguishable by the purple colour of the freshly cut bean, and in general is a considerably hardier plant than the Criollo type. The Trinitario type is found growing in Malaya on the three Departmental Stations at Serdang, Cheras, and Temerloh, and a few isolated trees are known to occur in kampongs. Professor Cheesman was favourably impressed by the yielding capacity of this material, which is now locally designated as 'Serdang' type, and considered that in every respect it was unlikely to be inferior to anything obtainable from Ceylon.

The limited amount of available planting material has set a limit to the experimental planting which could be carried out during the past year. Any such experimental planting fulfils, of course, the dual purpose of supplying information on agronomic problems and of helping to bulk up further supplies of planting material. Realizing that with the co-operation of estates a wider range of experiments could be carried out and a larger acreage of cocoa could be planted than by the Department itself, it was decided in April, 1948, that all cocoa pods obtained from the Departmental Stations during the year should be distributed free to interested estates for experiments on approved lines, and it was not until the beginning of 1949 that Departmental supplies of planting material were utilized for Departmental experiments.

The successful establishment of a cocoa industry in Malaya demands not only material of high inherent yielding capacity but also material of a sufficiently high quality to give a product acceptable to the manufacturer. The actual quality of the cocoa which could be prepared from Malayan

Trinitario trees has not yet been determined because the preparation of commercial samples depends upon the fermentation of an adequate quantity of beans, and so far insufficient pods have been obtained at any one time to give enough beans to carry out normal fermentation. The technique of fermenting small samples of cocoa beans in order to obtain an idea of the quality of the product has not yet been perfected, but already a certain number of small samples have been prepared in the chemical laboratories of the Department of Agriculture and have been submitted to manufacturers in England for a report.

An account of the experiments already laid down on estates and on Departmental Stations is given in an article published in this Journal, and the policy governing the distribution of seed between experiments on cocoa as a sole crop and experiments on cocoa in combination with other crops is clarified. In connexion with the growing of cocoa together with rubber the attention of readers is drawn to the relative portions of this article which contain the most recent official views from Ceylon on this practice.

Vegetative Propagation of Tea.

The extension of tea cultivation in Malaya has been accomplished in the past by the planting of seed, which has resulted in an extremely mixed stand of tea bushes with consequent variance in yields and quality of tea. This variation in bushes is to be expected from seed from the cross-fertilization of unselected strains, and pure strains can be obtained only by vegetative methods since the tea plant is self-sterile.

Preliminary trials in vegetative propagation have been carried out at the Federal Experiment Station, Serdang, and an article by Mr. H. J. Simpson, who was in charge of the work, published in this issue, describes the technique adopted and the preliminary results obtained.

Cuttings planted in a nursery rooted so satisfactorily that an additional trial was laid down with cuttings planted direct in the field, and it was found that they became established equally as well as when first planted in a nursery.

It will be appreciated that the trials have not progressed beyond the successful establishment of a full stand of bushes by vegetative propagation, and nothing can yet be said about the full development of the tea bush grown by this method. It is argued, for instance, that the lack of a tap root, which is not developed by vegetative propagation, will at a later date seriously weaken the resistance of the tea bush to the results of severe pruning, since it is suggested that the tap root contains reserves of starch which are essential to carry the bush over this period. On the other hand experience in Ceylon indicates that tea bushes raised from cuttings are, under favourable circumstances, capable of producing roots which will fulfil the functions of a tap root with no loss of efficiency.

The Department has now embarked upon a programme of selection work with tea, and the Botanical Division is undertaking the selection of individual tea bushes both at the Federal Experiment Station, Serdang, and on tea estates, where planters are giving their active co-operation. Cuttings from these selected bushes will be struck at Serdang and eventually planted up in lines so that yield and quality comparisons can be made between the clones.

Grassland Improvement in Malaya.

In the January issue of this Journal an article on ecological factors affecting the growth of two of the more important pasture grasses in Malaya was published. A further article by the same author in this issue records experiments on the effect of leguminous trees on the growth and quality of grass. The rain tree (*Enterolobium saman*) is cited as a good leguminous shade tree because of its wide spreading habit and because it does not develop too dense a canopy. Under this tree Savannah grass (*Axonopus compressus* Beauv.), one of the grasses dealt with in the previous article, grows vigorously and can successfully combat competition of lalang and other undesirable coarse grasses. In addition, the yield and nutrient quality of the Savannah grass, as judged from weekly crop figures and chemical analyses, are greatly improved when the grass is grown in association with rain trees. The practical importance of these findings is obvious, and they give a clear indication of means of pasture improvement in Malaya, opening the way to the greater development of mixed farming with all its advantages.

The author also draws attention to the value of better growth of grass in the prevention and control of soil erosion.

Original Articles.

INVESTIGATIONS INTO THE GROWING OF COCOA IN MALAYA

BY

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Serious interest in the growing of cocoa in Malaya dates from the establishment of a ½ acre plot of Trinitario type cocoa at Serdang in 1934.(1) Some trees from this area came into bearing in 1937, and subsequently plots were established at Cheras and Temerloh Agricultural Stations from seed taken from the higher yielding trees at Serdang.

After the war interest in cocoa growing was considerably increased owing firstly to the greater world demand and secondly to the decreased yields being obtained in West Africa and the West Indies as a result of swollen shoot disease and Witches' Broom disease respectively. At the end of 1947 the Colonial Office arranged for Professor Cheesman to visit this country to report on the possibilities of establishing a cocoa industry. At about the same time an Agency house with extensive planting interests in the country imported a consignment of cocoa pods (Trinitario type) from Ceylon. Under the supervision of the Department of Agriculture seedlings from these pods were raised in an isolation nursery in the Ayer Hitam Forest Reserve. After careful scrutiny by the Entomology and Plant Pathology Divisions, about 15,000 of these seedlings were distributed for the establishment of trial blocks.

Subsequently Professor Cheesman advised against further large importations from Ceylon, and plans were drawn up for the use of seed produced from the Department's own plots for the establishment of further cocoa trial plots throughout the country.(2), (3)

This article describes in detail the work which has been carried out since Professor Cheesman's visit and discusses the policy being adopted.

Planting Material and Importation

Professor Cheesman considered the Serdang material, a Trinitario type cocoa which is established on a number of Departmental Stations, to be very promising, and he recommended that the fullest use be made of this material for multiplying stocks. He estimated that it would be possible from one original pod to obtain enough seed for planting 20 acres a year after the 5th year, and on this basis he calculated that 20,000 acres at least could be planted from Malayan seed beginning in 1953. Yield figures in Table I show that in fact this estimate would appear to be extremely conservative. Present production makes it possible to plant as much as 500

Table I.

Monthly Yields of Cocoa Plots at Agricultural Stations.

Station	Year of planting	Acreage	Planting distance (ft.)	No. of points	Actual number of trees (excluding recent supplies)	NUMBER OF PODS 1948 Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	1949 Jan.	Feb.	Mar.
Serdang ..	1934	0.5	15 x 15 (triangular)	108	83[2]	82	84	109	174	289	308	55	—	—	1	—	25	24	23	338
Cheras ..	1939	0.6	12 x 12	198	151[3]	*	559	856	542	669	402	188	665	131	50	166	252	230	464	459
Temerloh	1938	0.4	12 x 12	121	91[4]	—	—	—	48	20	—	(see note (4))			—	—	—	18	215	607
	1940	2.0	12 x 12	605	81	—	—	—	2	—	—	(see note (4))			—	—	—	—	22	71

* Not recorded.

Notes:—1. It will be noticed that many casualties have resulted from the lack of attention given to these pots at various periods during the war years. This is particularly noticeable where the plants were still very young at the outbreak of war.

2. Serdang. Half of this plot has suffered severely from *Ganoderma pseudoferreum*, and the missing trees are in this half.

3. Cheras. The majority of gaps are on a sandy portion of the area.

4. Temerloh. The crop has suffered severely from damage by squirrels, rats and Helopeltis. Control of Helopeltis with Agrocide (Benzene hexachloride) is now effective and the trapping of squirrels in cages has greatly reduced the damage done by these animals.

acres per year, and every acre can theoretically supply at the end of five years sufficient planting material for 250 acres. Thus if the whole 1949 crop is used for planting and if growth is satisfactory, sufficient seed will be produced in 1954 to plant 125,000 acres.Since a number of trees should come into bearing after the third year lesser amounts of seed should be available during 1952 and 1953. Attention is drawn to the notes in Table I, and in particular it should be pointed out that all plots were under 5 years of age when the war started and they suffered varying degrees of neglect during the period of Japanese occupation. The yields do not therefore give an indication of the productive capacity of cocoa in Malaya. The Cheras plot, which has survived the occupation better than the others, does, however, give some cause for optimism. In 12 months (February 1948—January 1949) 4,710 pods were produced from 151 trees, i.e. 31 pods per tree, giving a calculated quantity of 405 lbs. of dry cocoa. With a full stand of trees this is equivalent to about 800 lbs. of dry cocoa per acre. The mean weight of the pods was 0.96 lb. which is above the Nigerian standard.(1)

Nevertheless it is desirable that selected planting material should be obtained from other countries, and much attention has been given to the possibility of making large-scale importations from Ceylon. Improved planting material is not, however, obtainable from Ceylon since no selection has been done there on scientific principles, and Professor Cheesman has pointed out that all Trinidad experience suggests that the performance of seedling progeny from unproved selections is likely to be disappointing. Although there is no danger of introducing the major diseases of cocoa (swollen shoot and Witches' Broom) from Ceylon, nevertheless Ceylon cocoa is subject to a Phytophthora pod rot, to canker, and to a pod-boring insect pest. The possibility of introducing these pests and diseases together with the uncertain yielding ability of the Ceylon material does not justify the risks involved in introducing further large quantities.

Importations from Java are undesirable until the strictest quarantine measures can be applied, since the Cocoa moth (*Acrocercops cramerella*) is one of the two most serious pests of cocoa in Java and may be carried in the pods. Java planting material is not of a standard which, when this risk is considered, would justify the importation of any quantity of seed.

From the point of view of high yield, importations from the West Indies and West Africa, where considerable selection work has been done, are likely to be of far greater value than from elsewhere. Technical difficulties are, however, involved both in the carriage of the material over such great distances and in assuring that the serious diseases prevalent in these areas are not introduced. It is hoped, when an isolation nursery is ready and the technical difficulties of transport have been overcome, to introduce material of the very best clones from these two areas.

Although arrangements made for an isolation garden near Serdang to handle the earlier consignment from Ceylon were considered by Professor Cheesman to be reasonably safe he did not think that they should be over-strained, and subsequently, when the whole question of importations from the West Indies and West Africa was under consideration, it was agreed that it would be necessary to establish an isolation nursery on an island adjacent to a main port of entry. Arrrangements have now been made for the establishment of such a nursery on Pulau Tekong Island near Singapore and when this is ready (in the course of the next few months) it will be possible for small importations of planting material to be made.

Distribution of Seed and the Establishment of Trial Blocks.

Before the details of cocoa cultivation methods are investigated we require to know whether the cocoa tree will grow and yield satisfactorily on Malayan soils. It has been the Department's policy therefore to distribute seed as widely as possible, avoiding only those areas with soils so poor that cocoa was most unlikely to thrive. All estates which indicated an interest in the growing of cocoa in this country were therefore informed that the Department's policy was as follows.

Available seed over and above what was required for the establishment of the Department's own experimental blocks was to be distributed free for trials on estates under the following conditions:—

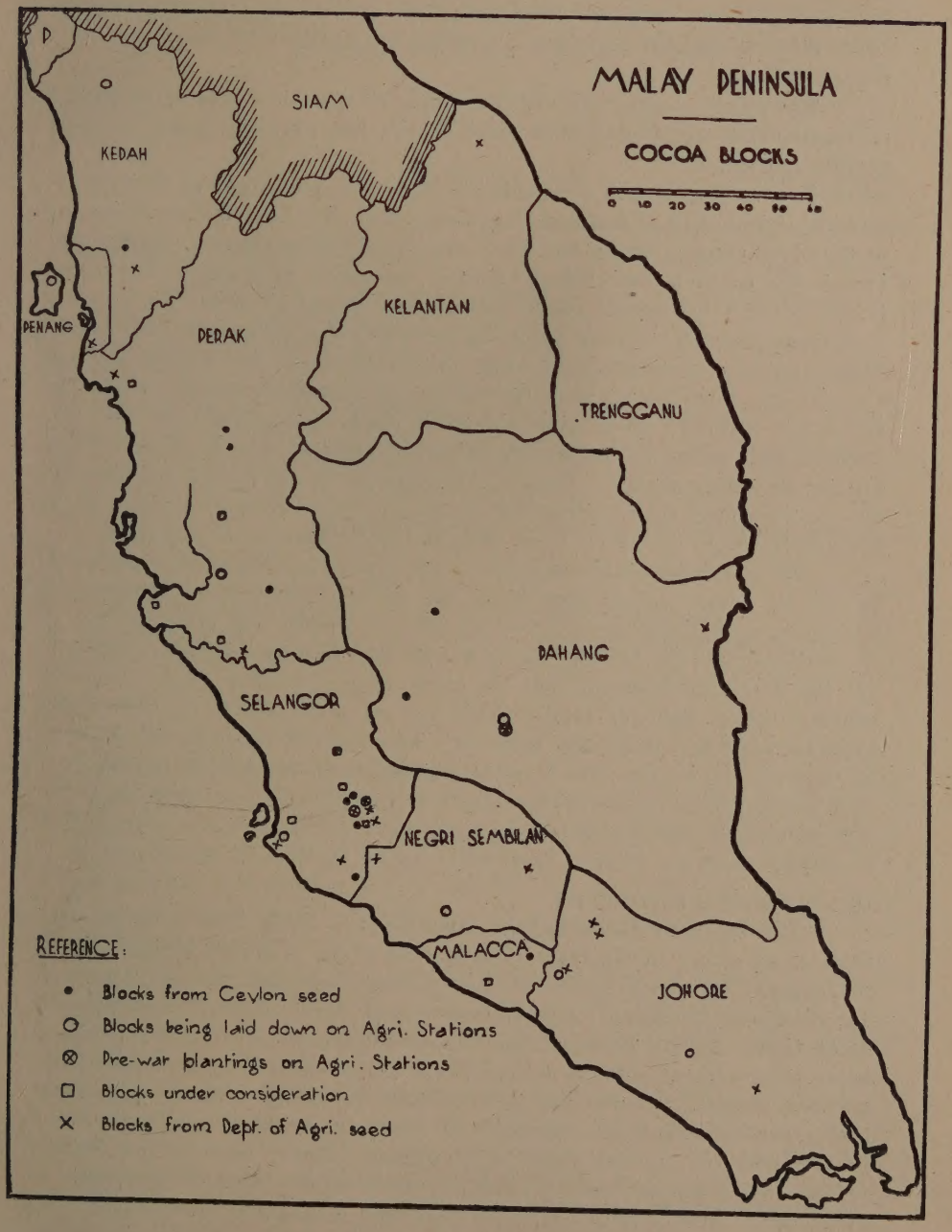
(a) An experimental area was to be a block of approximately 5 acres.
(b) The chosen site should be approved by the Department.
(c) The method of establishment and cultivation for the first 5 years should follow the recommendations of the Department.
(d) Simple field records should be kept and made available to the Department.

In order to speed up development it was subsequently decided that estate requirements should be met before those of the Department for its Agricultural Stations.

The result of the adoption of this policy is that there are at the present time in this country 16 blocks planted or about to be planted from seed distributed by this Department to estates, 9 areas on estates which are at the present time under consideration, and 8 experimental areas being laid down by the Department on its own Agricultural Stations. In addition there are 11 blocks established from the consignment of seed imported from Ceylon in 1947 and 3 blocks on Agricultural Stations planted before the war. The total acreage planted by March 1949 was 148 acres and seed for a further 84 acres had been issued. The distribution of these plantings is shown on the accompanying map.

Experimentation.

Professor Cheesman was of the opinion that, after the selection of soil and sites, the question of spacing, establishment, and shade were fundamental and to some extent inter-locked. Primary consideration has therefore


MALAY PENINSULA
COCOA BLOCKS
0 10 20 30 40 50 60
SIAM
KEDAH
PENANG
PERAK
KELANTAN
TRENGGANU
PAHANG
SELANGOR
NEGRI SEMBILAN
MALACCA
JOHORE
REFERENCE:
Blocks from Ceylon seed
Blocks being laid down on Agri. Stations
Pre-war plantings on Agri. Stations
Blocks under consideration
Blocks from Dept. of Agri. seed

been given to these factors in the laying down both of the standard block for estate planting and the experiment designed for Agricultural Stations.

ESTATE BLOCKS.

The estate blocks were kept as simple as possible. The investigation of spacing was not included in these blocks but different types of shade are being tried.

It was considered advisable in the first plantings in Malaya to establish cocoa by the traditional system which has been found successful in the older cocoa growing countries such as the West Indies. Under this system the cocoa is established under a succession of shades. The cocoa is first planted in 'ground shade' which may consist of either low-growing food crops such as *Colocasia* species and tapioca (as commonly used in the West Indies), or leguminous bush covers such as the Tephrosias and Crotalarias. Such plants may be designated primary shades. When the cocoa has outgrown these plants a taller shade is required, and for this purpose such plants as banana or *Gliricidia maculata* may be used. These are the secondary shades. Finally, when the cocoa has spread and crowded out the secondary shade, permanent or tertiary shade trees are used. These are usually large spreading trees such as the Erythrinas or Albizzias.

The standard design for the estate blocks is shown in Diagram I. It will be noted that in each block one out of four tertiary shades, two secondary shades, and four out of six primary shades are being tried. In the earlier blocks the primary shade was planted in rows 3 ft. apart throughout the area, which meant that the cocoa rows were only 1½ ft. from the nearest row of primary shade. This has in many instances been found to be too close and these near rows have been cut out leaving only the rows 4½ ft. from the cocoa. The secondary shade, bananas and Gliricidia, have been planted 6 ft. from the cocoa trees both within and between the rows. The permanent shade trees have been planted 24 ft. x 24 ft. with a view to cutting them out later to 48 ft. x 48 ft. or 72 ft. x 72 ft.

DEPARTMENTAL EXPERIMENTS.

The standard Departmental experiment is being laid down at eight Stations as shown in the map. The lay-out of the standard block is shown in Diagram II. Two blocks are being planted at each Station except at Tangkak and Temerloh. In this experiment three different spacings are being tried. It will be noted that the closest spacing, 8 ft. x 8 ft., is also being tried without permanent shade as is the practice in Grenada and parts of West Africa. Bananas are being planted as secondary shade throughout the experiment but the method of planting primary shade is being investigated in the sub-plots. The primary shades chosen are *Cajanus indicus* and *Tephrosia candida*. The *Crotalaria* species have in a number of areas been very heavily attacked by rust (*Maravalia crotalariae*), and experience may show that for this reason these species cannot be recommended for general use.

Diagram I.

Standard Trial Cocoa Block for Estates.

(4 to 5 acres)

One Tertiary (permanent) Shade[1]

	Secondary Shade Bananas	Secondary Shade *Gliricidia maculata*
One species of primary shade[2]	Plot 1	Plot 2
-do-	Plot 3	Plot 4
-do-	Plot 5	Plot 6
-do-	Plot 7	Plot 8

[1] Tertiary (Permanent) shades:—
Enterolobium saman—Rain Tree.
Peltophorum ferrugineum
Albizzia moluccana
Albizzia odoratissima

[2] Primary shades:—4 out of
Tephrosia vogelii
Tephrosia candida
Crotalaria anagyroides
Crotalaria usaramoensis
Leucaena glauca
Cajanus indicus

In addition to the above standard experiment, observation plots with other primary and tertiary shades have been laid down at the Federal Experiment Station, Serdang. The primary shades under observation, in addition to those mentioned above, are *Tephrosia vogelii* and *Cassia mimosoides*. *Adenanthera pavonina*, *Parkia roxburghii*, *Parkia speciosa*, *Peltophorum ferrugineum*, *Enterolobium saman* and *Albizzia odoratissima* are being tried as permanent shade trees. Plates I and II show primary and secondary shades at different stages.

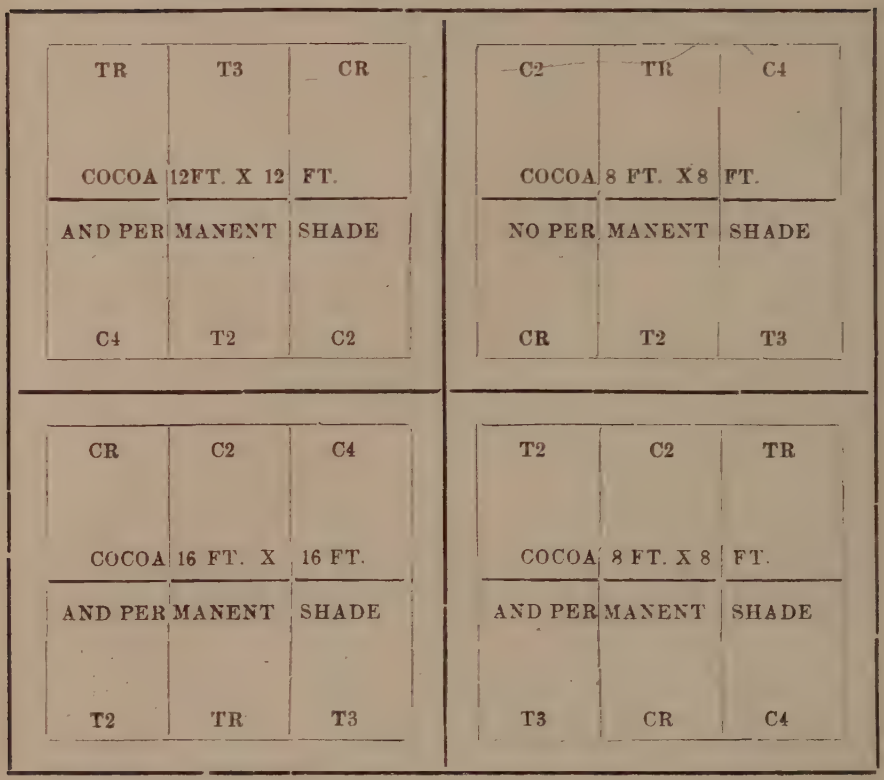
The trial blocks and experiments described above are field trials which have already been laid down. A number of other lines of work have, however, already been started or are under consideration. The problems involved are discussed briefly below.

(i) *Propagation.* Detailed yield records of the trees at Serdang were kept before the war and have been continued since the war. It has been found in Trinidad that yield records taken for a few years are sufficient to detect the higher yielding trees; in other words trees in an even stand which are high yielders for a few years prove to be high yielders throughout their life.

Diagram II.

Cocoa Cultivation Experiment on Agricultural Stations.

Diagram of one block (2 acres approximately)



Sub Plots. Primary shade.

T = *Tephrosia candida.*

C = *Cajanus indicus.*

R = Ring planting of primary shade.

2 = Thick planting, i.e. in lines every 2 ft., and 2 ft. from the cocoa row.

3 & 4 = Sparse planting, i.e. in single lines on either side of the cocoa row and 3 or 4 ft. from it, as indicated.

Permanent shade—*Parkia speciosa, Peltophorum ferrugineum* or *Albizzia odoratissima.*

It is hoped, therefore, that selection within our own material can start at an early date, and with this in view a study of the technique of the vegetative propagation of cocoa has already been started. The most satisfactory way of propagating cocoa for planting in the field is by means of cuttings. The practice in Trinidad is first to establish a multiplication nursery of the desired clone by budding on to seedling stocks and planting out these budded plants in multiplication nurseries. From these nurseries cuttings are taken and rooted for subsequent planting in the field. Initial success has been attained at Serdang both with budding and with the strik-

PLATE I.

Primary shade (*Cajanus indicus*) and secondary shade (bananas) growing in an area prepared for cocoa planting. A filled planting hole for cocoa can be seen in the foreground.

PLATE II.

A cocoa plant four months after transplanting, showing primary shade (*Tephrosia vogelii*), with secondary shade (bananas) in the background.

ing of cuttings, and the results obtained will be described in a future article. The value of growing cocoa from cuttings has been strikingly described by Mr. Manuel Elgueta in the Cacao Information Bulletin of Costa Rica(4) as follows:

> "The importance of the work of selection in Trinidad will be appreciated when reference is made to commercial plantations. Opportunity was provided for a visit to the San Juan Estate, property of Mr. Francois Agustine, with 650 acres of cacao, comprising plantings of clones of various ages, from 4 to 11 years. The general appearance of the clonal plantation is extraordinary. The trees appear loaded with fruits of uniform size, in contrast to the seedling trees, which show considerable heterogeneity. Of particular significance was a trial demonstration of 100 trees from three clones planted alongside another 100 trees, but from seed coming from the same clones. The clonal trees appeared loaded with uniform fruits, whereas those from seed from the same source had few fruits and all were heterogeneous. The great majority of the clones are self-compatible, and entire plantations are found of trees derived from a single clone."

Until, however, clones have been selected and multiplication nurseries established, cocoa in Malaya will have to be raised from seed. Many methods of raising cocoa from seed have been tried but in all the chief cocoa growing countries some method of raising plants in nurseries is preferred to planting at stake. Although it is possible under favourable conditions to raise plants from seed at stake, rats, mole crickets and other pests have been found to be very destructive to the young plants. It has been reported that on one estate in Ceylon both methods have been used simultaneously, that is to say a basket plant is supplemented by the additional planting of seed at stake in the planting hole. As to methods of raising plants in the nursery, both planting in baskets and in beds have been successfully practised, and in Java a system of retaining the seedling in beds for a year or more has been used. It is intended to try these methods in Malaya, but at present the policy of germinating in sand beds, transferring to baskets, and planting out at 4 to 6 months old is being adopted since this method is considered in most cocoa growing countries to be sound practice.

(ii) *Establishment in the Field.* It has already been noted that in our first trial plots the traditional method of establishing cocoa in a succession of shades is being tried. Recently in West Africa a new method of establishment of cocoa in jungle areas has been found very successful. In this method the aim is to leave untouched those jungle trees which form the highest canopy of the jungle and to clear all the rest and replace it by cocoa. In addition to this some secondary shades such as bananas and Gliricidia are planted and natural vegetation (forest seedlings) is allowed to grow up with the cocoa, this natural vegetation being periodically cut back to avoid smothering the plants. It is the intention of the Department

to open up experimental cocoa areas from jungle when these methods will be tried.

(iii) *Interplanting of Cocoa with Other Tree Crops.* A great deal of interest has been shown in Malaya in the possibility of growing cocoa and rubber together in the same field. Cocoa and rubber have been planted together on a commercial basis in Ceylon and some good reports have been made on individual estates in that country. It is, however, the opinion of the Ceylon Department of Agriculture (who have not themselves carried out any experiments on planting cocoa in rubber) that it is not possible to draw any conclusions from the results available from estates on the success of cocoa and its effect on the yield of rubber. It is said that the general opinion in Ceylon is that stands of rubber of more than 40 to 50 trees per acre may be detrimental to cocoa, though stands of a 100 to 110 trees do exist. A further point worth mentioning with regard to Ceylon cocoa is that most of the crop is planted at an elevation of 1,000 feet or more, which is well above the height at which rubber is planted in Malaya.

In Trinidad, cocoa interplanted with rubber was a failure. In Java it has been stated that the system of growing cocoa under the shade of such plants as kapok, *Castilloa elastica* and Hevea, when practised on fertile soil, gave what appeared to be satisfactory results for a number of years but after a certain time the decline of the trees showed that a suitable leguminous tree was needed.(5) In New Guinea, planting with Hevea, kapok and coconuts (in one case all together in mixed cultivation) has also been tried.

Professor Cheesman expressed considerable doubt as to the value of rubber as a shade for cocoa but believed that it might prove feasible on the better soils in Malaya provided that neither rubber nor cocoa was expected to give the same return as it would with the other species absent. He regarded it as another question to be answered by experiment, and this view is emphasised by the varying experience in other countries and by the varying opinions held regarding the success of the Ceylon plantings. It would clearly be unwise with the scanty data available to embark on a wholesale policy of planting cocoa and rubber together in Malaya before such experimentation had proved its value, but it has always been recognised that this experimentation should start as soon as possible. The general policy of the Department, while seed supplies remained limited, has been to give priority to trial blocks designed to show, in the first place, whether cocoa can be grown successfully as a sole crop, before subjecting it to competition with crops which are known to grow very vigorously in this country. But the advantages of growing two crops together may be considerable, and trials with the planting of cocoa and rubber together were laid down on an estate on Pahang Volcanic soil in 1948 with the co-operation of the Department. In these experiments the rubber is in one case 'avenue' planted and in the other 'clump' planted. It is the intention of the Department, as long as seed supplies permit it, to lay down further trials

on other good soils in the country. Plots are also shortly to be laid down in which cocoa is to be planted in combination with coconuts, oil palms and Manila hemp.

When two tree crops are planted together, if one of these crops is planted at its optimum stand as a sole crop and the second crop is planted between the rows, then the yield of the first crop may be expected to be reduced. But by how much the return obtained from the second crop will compensate, or more than compensate, for this yield reduction will depend on the prices being paid for the two products.

The problem of how to grow two such crops together is therefore an economic as well as an agronomic question, and (provided of course that the two crops will grow well together) it is desirable to find out what yields would result from different arrangements of the two crops in the field. Experiments should be designed to this end. It is probably best not to plant either of the two crops at its optimum stand as a sole crop. On the other hand, owing to the possibility that the two root systems may make better use of the soil than one, it may be possible to plant both crops at more than half stand and, with favourable prices, to obtain an enhanced total return.

Acknowledgement.

Acknowledgement is made to Mr. R. G. H. Wilshaw, Acting Director of Agriculture, who was responsible for making arrangements for the first plantings on estates and for the design of the estate trial blocks. I am also grateful to him for assistance given in the preparation of this article.

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PROPAGATION OF TEA FROM CUTTINGS

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Introduction.

An examination of the bushes in any tea field, even to the casual observer, reveals the great variation that exists between individual bushes. Some show a tendency to grow upright, others to spread and branch close to the ground. Some are vigorous free 'flushers' giving high yields while others grow slowly and give poor yields. In addition to these gross physical differences there are equally numerous and as wide variations between such internal characters as colour, tannin content, flavour and fermenting capacity. Such differences are only to be expected when dealing not only with what is virtually an unselected crop but in addition a plant that is self-sterile and depends upon cross fertilization for seed production. The so-called selected 'jats' are merely varieties and are far from being pure selected strains as some planters are led to believe. Such material, in the case of tea, can be produced only by vegetative methods, since the tea plant as stated before is self-sterile. Thus plants raised from seed must of necessity have all the characteristics of at least two parents, even if these two parents are themselves mono-clonal or pure-bred.

The commercial importance of raising high-quality bushes is obvious if it is appreciated that in any unselected area half the bushes will be below average and a proportion may even be complete failures. If these failures and the poor yielders can be replaced by bushes which are equal to the best in the field then the overall average for that area will be increased materially.

While planters were forced to employ seedling material the best they could do to raise the general field average was to obtain seed from gardens which had been specially planted from seed obtained from selected parents and to hope that the resultant progeny would be at least equal to the average of the two parents, if no better. By vegetative propagation of these selected parents the offspring is not only known but must of necessity be equal to the original bush. The importance of vegetative propagation is thus obvious.

Another advantage is that there is no need to have special areas reserved for the seed bearers. These, being widely planted, not only occupy much valuable land but are also unproductive for at least 8 to 10 years. Mother bushes can, if not required for cuttings, be brought into the plucking round in less than 3 months in the lowlands by pruning back and yet be ready

again for supplying cuttings within 4 to 5 months after plucking ceases. The number of unproductive bushes can therefore be regulated to suit any particular planting programme.

In the past numerous attempts have been made to work out a satisfactory method of vegetative propagation of the tea bush that could be adopted on a commercial scale but it was not until the war years that the Tea Research Institute of Ceylon finalised a method which has such possibilities.

The following account of the preliminary trials laid down at the Federal Experiment Station, Serdang, utilising this method is written in the hope that tea estates will commence selection and vegetative propagation for themselves, not only to replace the poor quality bushes now in existence on their estates but also for the supply of selected material for sale to new estates that may be opened in the future.

Selection of Mother Bushes.

Research work in Ceylon has shown that there is a very wide difference between the rooting capacity of cuttings from individual bushes. Some are extremely difficult and need special technique to obtain even moderate successes while others root freely. It is obvious that these latter types are the most useful from the commercial aspect and especially so during the initial stages of grading up fields.

This being the case, it was decided for the Federal Experiment Station trials to select mother bushes over as wide an area as possible; to test these mainly for rooting capacity in the first instance, and then to select the high-yielders from those that rooted easily. Actual yields of the individual bushes were not taken, as by working on the fact, discovered by the Tea Research Institute of Ceylon, that the spread of the planting table is closely related to yield, it is possible to pick out potential high-yielders by selecting bushes with a wide spread. Choosing a diameter of 5 ft. as the minimum it was found that sufficient bushes were retained for the first gross selection. The number was eventually reduced to 101 by discarding all bushes that were not surrounded by four normal ones (thus giving the selected bush an undue advantage which could account for the exceptional size) together with all bushes that produced a small number of shoots (flush) and those that produced their 'flush' in the centre of the plucking table only, with the side branches failing to reach plucking height.

A certain number of bushes were selected from the tea-seed bearers, but in this case only bushes that showed a natural tendency to low branching and those having their branches at a wide angle to the main stems were chosen. This is the type that normally produces a bush with a wide-spreading frame.

In order to obtain shoots suited to giving cuttings, the selected bushes, if in plucking, were taken out of the round and the young plucking shoots allowed to develop. In the case of the seed bearers, when these were pruned

back to a height of about 4 ft. they automatically developed a large number of shoots but it was found that the quality of this material was rather poor as it was thin and tended to branch too freely. Further cutting back to 2 ft. or less from the ground would prove beneficial in forcing clean straight shoots. The cutting back of mature bushes to a height of 2 ft. or less at one operation in the lowlands is not, however, recommended as it will cause numerous deaths. In the highlands owing to the greater starch reserves in the plants severe cutting back in one operation may be resorted to without too high a percentage of deaths.

Method of Propagation.

When the young shoots have developed to the stage when the bark on the lower part has become fully brown they are ready for taking cuttings. It was found that this stage was reached in about 2 to 3 months from high-cut seed bearers but bushes in plucking required 4 to 5 months. These periods apply of course only to lowland conditions and would be considerably lengthened for highland tea. The shoot is cut from the parent plant, and internodal cuttings, consisting of one fully mature leaf plus the small length of stem between the two leaves are taken from the central portion of it; the top green sappy portion and the over-mature bottom one or two nodes of the stem are discarded.

The ideal type of cutting was found to be one with a fully mature leaf, the internode long and large in diameter, the bark tinged with red/brown colour, and the axillary shoots which develop from the buds in the axils of the leaves showing their 'fish' leaves and the next leaf and bud. This is a slight variation of the Ceylon practice where the cutting is generally taken before the axillary shoot develops to such a length. It was also found advisable not to shorten this axillary shoot, as it appears to aid rooting.

The cuttings are taken with a sharp knife, the cut being made just below each leaf base. From four to six or more good cuttings can be obtained from a well developed shoot. If the cuttings are not to be planted at once they should be kept in water until required. It is, however, recommended that cutting of the shoots from the parent plants should be done early in the morning, the shoots taken straight to the nursery beds, and the cuttings made and planted at once. With teams of three, one man making the cuttings, another planting and the third shading, the whole procedure is rapid and continuous. This procedure was adopted at the Federal Experiment Station, all planting and subsequent shading being as far as possible completed for the day by 10.30 a.m.

Preparation of Nursery.

A piece of ground in the General Nursery was chosen as being moderately fertile and adjacent to a good water supply. The fertility was further built up by incorporating 20 tons of compost per acre and top dressing with a complete N.P.K. mixture. The beds were 4 ft. wide with 1½ ft.

between beds; this allows of easy access to all parts of the nursery. It is advisable to construct the beds at least 2 to 3 weeks before it is desired to start planting so that weed seeds will have time to germinate and a final weeding of the bed can be undertaken. Should the surface of the soil become at all compacted through heavy rain or by the labourers' feet, it must be loosened before inserting the cuttings, otherwise the basal portion is damaged and the cutting will fail to grow.*

Planting.

Planting of the cutting consists of placing the stem carefully in the soil in such a way that the base of the leaf is just at ground level and the leaf is lying flat along the ground. In the case of cuttings in which the axillary bud has not yet developed into a small shoot care must be taken not to bury the bud.

The cuttings should be planted in rows and spaced so that the leaves are just touching but not overlapping. Such close planting enables a very large number to be planted in a very small area as the planting distances average about 6 ins. between rows and 2 ins to 3 ins. in the row.

As soon as the cuttings have been planted they should be well watered in order to settle the soil around the stems and then heavily shaded with bracken fern, *Gleichenia Linearis*, the fern stalks being pushed into the ground between the leaves of the cuttings so that a thick canopy of leaf is formed some 4 to 6 ins. above the cuttings. The density of the shade has to be judged and learnt by experience. If it is too heavy the cuttings will fail, owing to lack of light, if too light they will dry out. As a working standard the shade should be so thick that the ground is barely visible when viewed from above.

After-Care of Cuttings.

Once planted, the cuttings require little attention beyond watering if the weather is dry, attention to shade, and later weeding. If the beds have been well prepared, weed growth should be slight owing to the heavy shade both from the cuttings themselves and from the fern. Care must be taken in removing weeds that the soil around the cuttings is not disturbed and that the shade is not left off for a moment longer than is absolutely necessary as the cuttings in the early stages are extremely sensitive to drying out and sun scorch. As the cuttings develop, the shade is gradually reduced, and in these trials was completely removed from the more advanced areas as soon as the new shoots on the cuttings were 5 to 6 ins. high.

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* Later observation of the cuttings rooted in these beds showed that a much larger percentage of cuttings rooted successfully near the edge of the beds than in the centre. This indicates that it is likely to be advisable in Malaya to follow the Ceylon practice of constructing beds on a drainage layer of small road metal or other suitable material. (*vide Tea Quarterly*, Vol. XIV, Pt. III, Oct. 1941)—Ed.

Results.

Of a total of 10,842 cuttings planted during the period February to July 3,647 were successfully rooted. This gives an overall average of 33.6 per cent. which although not high is very encouraging, especially in view of the fact that owing to inexperience poor successes were obtained during the first few weeks and these have tended to lower the general average considerably.

Weather conditions and the maturity of the cuttings rather than the skill of the operator appear to be the decisive factors. It was also found that cuttings without a developed axillary shoot were slow to commence growth, while those with the shoots already well developed continued to grow slowly and eventually gave a greater percentage of successes. After three months the majority of the early cuttings which had been planted without the axillary shoots developed, were found to have calloused well and were developing small roots; two months later the cuttings had developed shoots some 4 to 5 ins. long and a mass of fine roots had been formed. Cuttings planted with the axillary shoots well developed reached a similar stage of development in about three months.

In spite of dry weather, growths from early August until the end of September (when this report was compiled) was extremely rapid. The photographs accompanying this article illustrate the good growth made and the mass of roots formed.

An important fact was that, although there appeared to be fairly well marked differences between the rooting capacity of cuttings from individual bushes, in no case was there any complete failure. Another difference noticed was that some were more rapid growers than others, but this difference, indicating more rapid rooters, was not so marked as to be of any real commercial importance.

The above fact opens up the field of selection very considerably as all plants may be considered as future mother bushes if so required. It is, therefore, recommended that a more careful selection of the mother bushes should take place than was carried out in these early trials. The method recommended and which was put into practice at the Federal Experiment Station as soon as there were indications that all bushes were going to be successful rooters is that evolved by the Tea Research Institute, Ceylon, of flush counts.

This is a simple and rapid method of classifying the best 2 per cent. of any selected population and consists of counting the number of plucking shoots from the individual bushes over a period up to 20 pluckings. The following procedure is recommended: " Record the flush counts for each mother bush and total the counts at the end of the fourth and eighth pluckings. If the bushes comprising the best 2 per cent. are made up of the same individuals on each of these occasions, then they may be chosen for pro-

Left. Tea cutting 6 months old. Note good growth of roots.
Right. Tea cutting ready for planting.

Tea cuttings, showing long axillary shoot and method of shading.

Tea cuttings—age 6 months. Ncte variation in growth. Cuttings on left were planted without developed axillary shoot. Those to the back with shoot developed. Shaded nurseries in background.

pagation. If not, then the counting must be continued for another group of four pluckings or till stability is reached. It is immaterial whether the ranking within the top 2 per cent. remains stable, so long as no gaps occur in the order of merit."†

Planting Cuttings direct into the Field.

When it became obvious that propagation of tea from cuttings in the lowlands of Malaya was going to present very few difficulties a small trial was laid down in which cuttings were planted direct into the field instead of into nurseries. An old diseased patch was chosen which had been treated by digging over and removal of all tea roots and then planted with bush covers consisting of a mixture of *Crotalaria usaramoensis* and *Tephrosia Vogelii*. It had been previously decided that this area should be replanted adopting the new hedge row method of spacing the plants 2 ft. in the rows and 5 ft. between rows.

Trenches 1 ft. wide and 9 ins. deep were opened 5 ft. apart, the lower half was filled with compost and then refilled with top soil from the neighbouring area. The tea cuttings, which were taken from mother bushes in the immediate vicinity, were planted in a single row down the centre of the prepared trenches, the distance between cuttings being the length of the tea leaf attached to the cutting. The normal procedure of shading with fern was adopted, but in addition, the whole plot was well shaded by the bush covers which were then about 3 ft. high and casting just sufficient shade to keep the area well ventilated but moist.

In spite of the fact that cuttings were taken during the dry weather of late May there were practically no failures, and by the end of September a sufficient number had rooted to give more than the required stand of plants.

It is too early to say whether the method can be extended to full field planting but it is full of possibilities. The great advantage of this method lies in the fact that no transplanting is necessary; the high losses of plants which is experienced during this operation is avoided, and the young plants receive no set back.

Direct planting of cuttings into the field should also prove less expensive than the nursery method as it does away with the cost of transplanting.

Summary of Conclusions.

1. The value of vegetative propagation is discussed as a means of raising average yields of tea estates.

2. The method of the Tea Research Institute of Ceylon of propagating tea by internodal cuttings and its adoption to lowland Malayan conditions is described.

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† Extract from the Tea Quarterly. Vol XIV, Part III, Oct. 1941.

3. Cuttings in which the axillary shoot has developed, the 'fish' leaf, first true leaf and a bud, root more quickly than those with the axillary bud still undeveloped.

4. Although fairly well marked differences were observed between the rooting capacity of cuttings of individual bushes, it is considered that these are not sufficiently great to be of commercial importance. This considerably widens the field of selection as all bushes may be regarded as potential mother bushes.

5. A preliminary small scale field trial of planting cuttings direct into their permanent positions instead of undergoing nursery treatment is described.

6. Cuttings planted direct in the field proved to be no more difficult to root than under nursery conditions and sufficient successes were obtained to produce a full stand of bushes.

Acknowledgement.

The writer wishes to record his indebtedness to Inche' Ismail bin Abu Bakar, Agricultural Subordinate, Federal Experiment Station, Serdang, for his assistance in marking mother bushes and supervising the nursery work.

BENEFICIAL EFFECTS OF SOME LEGUMINOUS SHADE TREES ON GRASSLAND IN MALAYA

BY

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Introduction.

For some years prior to 1938 many originally casual observations had convinced the writer that grass growing under the shade of Rain Trees, *Enterolobium saman,* with their wide spreading, not too dense canopies, is of stronger growth and better quality than grass growing in situations which are exposed to the sun. It was also noticed that very often there is a change in species, too, from "love grass," *Chrysopogon aciculatus*, or "lalang", *Imperata cylindrica*, in exposed neighbouring situations, to Savannah grass, *Axonopus compressus*, under the Rain Trees.

The importance of combining animal husbandry with crop production is becoming more widely appreciated, and the primary essential for the extension of cattle raising in Malaya is the provision of better quality of grazing than is now generally available.

It will be appreciated, therefore, that since *Axonopus compressus*, Beauv. is one of the best and probably the most suitable of pasture grasses for Malayan conditions of leached soil and wet tropical climate, any circumstances which might increase its rate of growth and the extent of its establishment could be of considerable benefit to the country.

The peninsula of Malaya lies between latitudes 1°N. and 7°N. and has lowland mean maximum air temperatures of approximately between 85° and 90°F. Sun temperatures and exposed soil surface temperatures are, of course, considerably in excess of these. Mean annual rainfall varies approximately between 70 and 200 ins. with a general average of 90 to 100 ins. It can readily be appreciated, therefore, that the climate of Malaya is a somewhat severe wet tropical one, and is likely to have particularly severe effects on any exposed or poorly covered soil.

Test of Grassland Production Under Legume Shade.

In order to examine the possibilities indicated by the above observation of stronger growth, and to compare weight of grass (*Axonopus compressus*) cut under Rain Trees with results of grass-cutting tests (mixed and other grasses) carried out at the Central Experiment Station, Serdang, in 1937, in apparently less favourable conditions, a grass-cutting test was made in 1938 in Kuala Lumpur.

This test of *Axonopus compressus* pasture yields was carried out on a small lawn under the shade of a large Rain Tree. It was continued initially for a few months, but as results were proving of particular interest, it was

extended to 15 months (63 weeks) from 22nd October, 1938, to 2nd January, 1940.

A summary of the results is given in Table I.

Table I.

Yields of *Axonopus compressus* under Shade of Rain Tree.

Conditions of Test	Plots of 100 sq. yds.	Total Weight of Grass per 100 sq. yds. in 15 months	Equiv. Yield per acre per annum	Approx Carrying Capacity per Ox*
		lbs.	lbs.	acres
Valley quartzite soil with *Axonopus compressus* under *Enterolobium saman.*	Plot A	476	19,015	1.15
	Plot B	567	22,665	0.97
	Average	522	20,840	1.06

* A grazing requirement of 60 lbs. per ox per day is allowed in calculating the cattle carrying capacity.

Fallen leaves from the Rain Trees were carefully sorted out and removed before weighing the cut grass.

Rainfall during the period was, except for January, 1938, below average, particularly in November and December of both 1938 and 1939, but for which yields might have been slightly higher.

The full records (Table III) show also an interesting detail; notably higher yields occurred after the accidental rest from cutting for one week in November, 1939, indicating the importance of resting periods as would be included in a system of controlled grazing and efficient pasture management.

In relating these grass-cutting tests to pasture yields for grazing cattle, it should be stated that the *Axonopus compressus* occurred as a pure sward, and always tends to do so under similar conditions, so that the unpredictable effects of selective grazing of different species need not be considered here.

Local Grazing Lands.

In Malaya, milch and draft cattle and buffaloes, in the neighbourhood of towns, are grazed chiefly along roadsides, by banks of streams and rivers, or on any casual piece of grassy land, as well as being stall fed with grass cut in similar places.

Buffaloes used for cultivation of padi fields graze in the padi fields during the fallow season, and on any waste land available while the padi is growing. This grazing during the padi season has been and is a considerable problem, and, scattered throughout the country, but mainly east of the central mountain range, a few large areas of rough or rather poor

grazing lands have been developed with the purpose of trying to provide better or more nearly adequate grazing for such cattle.

These pastures, however, and grasses also on most smaller casual grazing lands, are poor both in the quantity and quality of grazing which they provide.

Nearly all pasture grasses, despite hardiness and adaptability, are of relatively weak herbaceous growth, and have little depth of roots. In exposed conditions in Malaya, their growth is often not very much above the balance of existence, and when regularly grazed and trampled upon by cattle or severely treated in any way, the grass cover of the soil becomes a very thin one indeed.

In particular instances the surface of the soil is so very poorly covered by weak growth of grass, that it is of little value as grazing, and may not be of much use in checking soil deterioration or even erosion.

As already emphasised, the amount of grass produced on the usual "grazing" land is very low, and records of tests carried out in 1937 at the Central Experiment Station, Serdang, for different conditions of soil and very light shade, demonstrate this.

The records at Serdang were obtained over a four-month period by cutting the grass of 1/10th acre plots on seventeen occasions at weekly intervals from 4th January to 26th April 1937, inclusive.

Table II summarises the results.

Table II.

Yields of Grass on Grazing Land.

Type of Land	Total Weight of Grass per 1/10th acre, over 17 weeks	Calc. Yield per acre per annum	Approximate Carrying Capacity per Ox
	lbs.	lbs.	acres
Poor clay soil with natural mixture of grasses ..	139	4,180	5.0
Valley quartzite soil with "lalang grass" which has been scythed weekly for several years ..	164	4,930	4.4
Light sandy soil with natural grasses lightly shaded ..	262	7,880	3.0
Light sandy soil turfed with *Axonopus affinis* and lightly shaded by *Casuarina equisetifolia* ..	312	9,380	2.3

Beneficial Effects of Suitable Shade Trees.

The results of the 1938-1940 test (Table I) compared with the results of the 1937 tests (Table II) are so very much in favour of the former that they strongly support the observations of the good growth of *Axonopus compressus* grass under Rain Trees. The greater weight of grass cut under the Rain Tree probably included a greater percentage of moisture (see Table IV), but of insufficient amount materially to affect the comparisons.

Table III.

Growth of Savannah grass, *Axonopus compressus*, under Rain Tree, *Enterolobium saman*.

Weekly Cuttings as Test for Yields as Pasture Grass, 1938-1939.

Date of Cutting		Monthly Rainfall		Yields per 100 sq. yds. Plot A		Plot B	
		ins.		lbs.	lbs.	lbs.	lbs.
1938							
October	22			8		6½	
	29	9		9	17	8	14½
November	7			9		8	
	12			6		5	
	18		dry	6½		5	
	26	4	weather	8	29½	6½	24½
December	3			8		6½	
	10			6½		6	
	19			12		10	
	24			7½		6½	
	31	6		9	43	8	37
					(5 weeks)		(5 weeks)
1939							
January	7			10		8	
	14			9		8	
	23			12½		10½	
	28	12		6½	38	5	31½
February	4			9		7	
	11			6½		5	
	18		dry	6½		6	
	25	4	weather	7	29	6	24
March	4			6½		5	
	11			7		6	
	18			9		8	
	25	7		9½	32	8½	27½
April	3			10½		9	
	10			10		8½	
	17		dry	9		8	
	24	7	weather	9	38½	8	33½
May	1			8		6½	
	8			10		7½	
	15			12		10	
	22			9		8	
	29	7	very dry	8	47	6½	38½
					(5 weeks)		(5 weeks)
June	5			6½		5	
	12		light rains	9		7	
	19		dry	9		6½	
	26	5		8	32½	6½	25

Date of Cutting		Monthly Rainfall		Yields per 100 sq. yds.			
				Plot A		Plot B	
		ins.		lbs.	lbs.	lbs.	lbs.
July	4		light rains	10½		9	
	10			8		6½	
	17		very dry	6½		5	
	24			4½		3½	
	31	2	(29/7 slight shower only)	4	33½	3½	27½
					(5 weeks)		(5 weeks)
August	7			4½		4	
	14			5		4½	
	21		light rains	8½		7	
	28	3		9	27	8½	24
September	4			8		6½	
	11			10½		9	
	18		rains	13		12	
	25	8		11½	43	10½	38
October	2			12		10½	
	9			12½		11	
	16		heavy storms	10		9	
	23			10½		9	
	30	9		10	55	8½	48
					(5 weeks)		(5 weeks)
November	6			10½		9	
	13		fine rains	—		—	
	20			23		19	
	27	4		18½	52	15	43
December	4			14½		12	
	11			10		8	
	18			10½		9	
	26	3	very dry	8		6½	
1940							
January	2			6½	49½	5	40½
					(5 weeks)		(5 weeks)
63 weeks ..		90 ins.		566½ lbs.		477.0 lbs.	
		Average per week ..		8.99 lbs.		7.57 lbs.	
		Equivalent yield per acre per annum ..		22,626 lbs.		19,052 lbs.	

Note.—Regular cutting at weekly intervals does not seem to have had an adverse effect on yields, rather the reverse, but it is of particular interest to note that the accidental rest from cutting on 13th November, 1939, appears also to have had a very good effect, with better yields for a few subsequent weeks in spite of only very light rainfall.

Table IV.

Moisture and Protein Analyses of Cut Grass, *Axonopus compressus*, from Plots of Shaded and Unshaded Grassland.

Date of Cutting	Under Legume Shade						Under Other Shade						Unshaded					
	Enterolobium saman		*Enterolobium cyclocarpum*		*Pongamia glabra*		Brazil Nut Tree		Oil Palm		*Couroupita guianensis*		—		—		—	
	Moisture	Protein (dry basis)	Moisture	Protein (dry basis)	Moisture	Protein (dry basis)	Moisture	Protein (dry basis)	Moisture	Protein (dry basis)	Moisture	Protein (dry basis)	Moisture	Protein (dry basis)	Moisture	Protein (dry basis)	Moisture	Protein (dry basis)
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1947															62.16	10.15		
Nov. 6	76.76	14.29					73.42	12.08					73.06	12.62			74.98	11.31
13					77.22	15.19			73.54	10.51					71.96	11.98		
21			77.25	13.94							77.00	12.09						
28	75.14	15.09					74.02	13.47					76.26	13.31				
Dec. 5					77.68	13.26			74.68	9.36							76.63	10.35
12			76.32	14.86							77.34	14.34			70.10	7.69		
19	78.51	14.69					79.20	10.97					72.67	10.06				
27					78.80	15.10			77.71	10.54								
1948																	72.88	8.96
Jan. 2			78.59	14.53							74.77	10.90			69.60	7.57		
9	79.49	15.94					79.12	12.60					72.27	9.45				
16					76.59	14.91			73.91	9.81							73.59	9.16
24			79.85	15.58							75.01	13.09			66.74	12.00		
30	76.57	16.56					76.22	10.68					73.83	11.43				
Feb. 6					76.88	13.97			76.42	10.18							70.81	10.28
13			77.01	14.35							74.94	12.01			67.26	7.12		
20	78.02	15.38					73.87	10.56					68.61	10.26				
27					77.05	14.03					76.24	11.19					73.83	10.28
Mar. 5			75.71	15.31					69.82	8.81					66.22	7.13		
12	78.15	15.88					76.84	11.74			76.46	10.24	71.20	8.06				
19					78.62	10.52			73.36	9.39							69.95	8.12
26			77.00	12.25											64.10	6.96		
Apr. 3	74.77	11.14					76.16	9.91			62.79	9.76	71.16	9.64				
10					70.86	13.76											68.95	8.31
17			73.68	12.84					70.99	7.86								
Means ..	77.18	14.86	76.94	14.21	76.71	13.84	75.86	11.50	73.80	9.56	74.32	11.70	72.38	10.36	67.27	9.07	72.70	9.60
General Mean Protein	14.32 per cent.						10.92 per cent.						9.68 per cent.					

Oxidation of organic matter in the soil is so accelerated by high soil temperatures in direct strong sunlight, with eventual great loss, that adequate cover or shade of the soil is one of the first essentials for maintenance of fertility in the tropics. Such protection is also of very great importance in minimising the erosive action of heavy rainfall.

Provided that too much light is not excluded, beneficial effects of shade on pasture grass in the tropics can therefore be expected. The most apparent effect thereof and possibly the most important is a reduction of temperature, both of soil and air, and an accompanying increase in top-soil moisture content and possibly relative humidity.

In addition to the beneficial effects of shade, trees give an uninterrupted leaf-fall which adds humus to the surface of the soil, helping thus further to protect it and maintain fertility. Particularly, the small leaflets of the more suitable shade trees fall between the blades of grass. They do not cover the grass as large leaves would, nor interfere with photosynthesis and growth. Likewise, the shade of trees should not be too dense, for too much light would then be excluded.

Furthermore, trees, by reason of the large extent and deep penetration of their roots into the soil, give increased permeability and water-storage capacity to the soil. It is likely also, that, with their deep roots and continual leaf fall, they tend to counteract to a considerable extent the results of downward leaching of soluble soil minerals which must result from the more or less constant heavy rainfall of the Malayan climate.

Beneficial Effects of Leguminous Shade Trees.

Axonopus compressus and such shallow rooting grasses which appear not to compete with the Rain Tree, and are tolerant of and benefit by shade, seem also to benefit by association with leguminous trees more than with non-leguminous trees. Examination of surface roots of the Rain Tree of the original observations, and others, have been made, and these have been found to be very extensively nodulated. Subsequent chemical analyses of grass (Table IV) growing in different circumstances have shown a considerably higher figure for protein in the grass growing under leguminous shade trees.

The benefit by association may, therefore, be due to excess nitrogen being made available in the soil by excretion from or decomposition of Rhizobium nodules, and Rain Trees, and some other leguminous trees, may in fact function as legume associates, equivalent to some extent to the clovers usually occurring in good pasture in temperate climates. It is possible, however, that any additional nitrogen may be provided only with the fallen leaves.

On the other hand, chemical analyses of a brief series of soil samples concerned with other contemporary grassland observations have shown no appreciable improvement in soil fertility under a Rain Tree, and tend to

emphasise the importance of the reduced soil temperature alone. More detailed observations on these points are required and will be made.

Improved Nutritive Quality of Grass.

Subsequent further observations on growth accompanied by analyses of protein contents of grass under different trees, however, turn the argument again in favour of some additional nitrogen benefit from leguminous trees.

The better nutritive quality of *Axonopus compressus* (and possibly any grass) growing under Rain Trees and other leguminous shade trees, is indicated by the higher figures for protein shown by a series of chemical analyses which were made of this grass cut at 3-week intervals, on plots under leguminous trees, under other trees, and without any shade. (Table IV).

The dry-weight protein content of *Axonopus compressus* under the leguminous trees averaged 14.32 per cent.; under other trees and oil palms 10.92 per cent., and for unshaded grass 9.68 per cent.

The protein content (14.32 per cent.) of grass under the leguminous shade trees, of this experiment, is not very high compared with approximately 17 per cent. for good pasture grass of temperate climates, but it is considerably and significantly higher than the protein content of grass growing in the other circumstances of the test. The lower average (9.56 per cent.) for protein content of grass under oil palms compared with that (11.60 per cent.) for grass growing under other non-leguminous trees may also be significant.

The plots chosen for these analyses tests were all in one neighbourhood, close to the Department of Agriculture, Kuala Lumpur, and in similar situations. It was easy to find suitable plots of *Axonopus compressus* under shade trees but not easy to find good plots not under shade. This fact is itself a significant indication of the conditions needed for the good growth of this pasture grass.

The growth of grass and weight of cut grass under the leguminous shade trees was little greater than that of grass under other shade trees, but both were very considerably greater than that of grass in the exposed unshaded sites, as the following figures will show:—

Grass under leguminous trees	Average cut (3 weekly)	11	lbs. per 60 sq. ft. plot.
Grass under other shade trees	-do-	9	-do-
Grass unshaded ..	-do-	2¼	-do-

As already mentioned, the difference between grasses growing under shade and those in exposed, unshaded situations is not only an obvious difference in quality, but it is often a change in species, for different conditions of light, temperature, moisture and soil fertility suit different species. Usually, also, different species of grasses may be found growing under medium shade and under more dense shade.

Application of Beneficial Effects of Shade.

Medium shade provides ideal conditions for growth of Savannah grass or broad-leaved carpet-grass, *Axonopus compressus*. Wherever conditions are sufficiently favourable, this grass, with its vigorous stoloniferous habit, is able to suppress or supersede coarser grasses, including even lalang grass (*Imperata cylindrica* Beauv.) if cut or grazed, as the vigour of growth of *A. compressus* is raised above that of the coarser varieties in such circumstances.

It would seem logical, therefore, that in order to obtain maximum value from any land available for the purpose of grazing, it should be planted with fairly widely spaced, suitable shade trees, preferably wide-spreading leguminous trees, which will establish and maintain a medium degree of shade over the grass.

Another particular application of the beneficial effects of this shade is that, in particular circumstances, such protection of trees and the better growth of grass could prevent the development, or correct the continuation, of surface erosion. This may not seem, in general, a very pressing need at present in Malaya, but the yellow muddy appearance of many rivers following heavy rain is, particularly to some professional observers, a disturbing indication of this danger.

Field Trials.

As a result of the 1938-1940 test of pasture grass yields under Rain Tree shade, an experimental area was planted at the Central Experiment Station, Serdang, in 1940. Several acres of land were planted with *Axonopus compressus* and other pasture grasses, with and without young Rain Trees. This experiment did not survive the years 1942-45 (the occupation years), but a similar experimental area has again been planted. Such an experiment is necessarily a long term one, for full results must await the maturing of the Rain Trees in 15 to 20 years, and the results of suitable grazing experiments.

The possible disadvantages of the large primary lateral roots, which usually are developed prominently around the base of the trunk of the Rain Tree, have also to be considered with any scheme of pasture management. In theory these roots may seem to be a considerable nuisance, but in practice possibly rarely so.

Planting of Shade Trees.

Shade trees which can be recommended for improvement of grasslands are *Enterolobium saman* (the Rain Tree) and *Enterolobium cyclocarpum*; *Parkia* spp. ("Petai" and "Kedayong") might be nearly as good. *Albizzia odoratissima*, *A. Fastigiata*, E. Meyer., *Peltophorum ferrugineum*, planted more closely might also be useful.

Observations on rate of growth have been made, and it has been

noted that *Enterolobium saman* growing in good soil attains, in 20 years, a girth of 7 to 7½ ft., and a canopy diameter of 55 to 70 ft.

Shade trees should not be planted so close as to intensify too much the degree of shade, and the spacing of mature trees of *Enterolobium saman* in triangular arrangement at intervals of approximately 100 ft. is recommended as probably giving the ideal shade. If necessary, inter-planting with similar or smaller trees could be done for the earlier years of growth and these cut out as spread and shade increased. Interplanting with *Gliricidia maculata* is recommended.

The matter of the correct or optimum spacing of leguminous shade trees may require further study. A single tree provides a certain degree of shade and resulting increased humidity, which are beneficial to the grass beneath it. But with a number of adjacent trees, if they are spaced so as to give a complete canopy cover, the increased shade and humidity might well be so exaggerated as to be above optimum, and the fairly wide planting distance recommended above is suggested with this in mind.

In planting young shade trees, the advantage of good planting holes and of giving every encouragement for growth need hardly be emphasised.

Where suppression of "lalang" might be required, spray poisoning around the young tree to reduce competition in the early years would probably be necessary.

If an attempt were made to reclaim a large area of "sheet lalang," fire-control measures, including the planting of *Vitex pubescens*. Vahl. (Leban) as recommended by the Forestry Department, would probably be most necessary. ("Lalang and its Eradication", E. J. Strugnell, *Malayan Forester*, Vol. 3, 1934).

Meteorological Data.

Reference has been made to the tropical climate of Malaya, and it is appropriate to include in an appendix meteorological records which will illustrate the conditions of this climate, and the conditions to which the above observations refer.

Rainfall is the most variable of these phenomena, and rainfall records are given in greater detail than the other measurements of mean sunshine, mean minimum relative humidity, and air, grass minimum, and earth temperatures.

Rainfall is relatively uniform throughout the year, although with a minimum usually in July, but the average rainfall figures do not show the short very dry spell that almost invariably occurs some time in the year, nor the torrential rain of over 50 ins. a month that may fall, during the N.E. Monsoon, on the east coast during November or December.

Summary.

The beneficial effects, in the tropical climate of Malaya, of the shade, protection and association of the Rain Tree, *Enterolobium saman*, Prain, and

other species of leguminous shade trees, on the growth of grass, and of savannah grass, or broad-leaved carpet grass, *Axonopus compressus*, in particular, have been examined and described.

The additional effect of such legume shade-tree association in improving the nutritive quality of this locally most important pasture constituent, as indicated by increased protein content, is shown in the results of a series of chemical analyses.

The benefits of shade and good growth of grass in control of soil erosion are also indicated.

Meteorological data are included in an appendix.

These observations are not the results of a properly designed experiment, but arose from general observations of the very frequent good growth of grass under Rain Trees. The results and discussions arising out of these observations are considered of sufficient importance to merit publication and may be of wide interest.

Acknowledgement.

Acknowledgements are made to the Senior Chemist, Department of Agriculture, who carried out the moisture and protein analyses given in Table IV, and to the Director, Malayan Meteorological Service, for the supply of considerable meteorological data.

APPENDIX.

Meteorological Data.

Station	Latitude °N.	MEAN MONTHLY RAINFALL (inches) Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean Annual Rainfall
WEST COAST														
Alor Star ..	6.09	2.25	1.78	5.83	9.16	10.41	7.82	7.41	10.67	12.49	12.25	8.35	5.07	93.49
Bukit Mertajam ..	5.22	6.72	4.20	9.04	9.53	8.55	6.15	5.05	8.38	11.88	16.08	11.47	7.29	104.34
Taiping ..	4.52	14.01	11.65	17.30	19.63	12.63	7.24	6.51	9.57	12.57	20.50	18.76	15.24	165.61
Kuala Kangsar ..	4.46	5.84	4.86	7.29	8.63	5.93	3.91	3.45	5.46	7.03	10.89	10.53	7.25	81.07
Kuala Lumpur ..	3.08	6.82	6.25	9.22	10.81	8.36	4.96	4.01	6.25	7.39	11.05	10.09	9.33	94.54
Jelebu ..	2.57	4.85	3.36	6.37	6.75	5.60	3.63	3.12	3.82	4.41	7.16	7.94	7.57	64.58
Seremban ..	2.43	5.63	5.22	8.57	10.69	7.78	5.78	5.10	6.37	7.16	10.44	9.56	8.80	91.10
Malacca ..	2.12	5.02	2.68	6.20	7.94	7.27	7.95	7.79	8.80	9.92	9.74	9.15	7.66	90.12
Kluang ..	2.01	8.96	4.04	9.48	9.90	10.17	6.76	3.72	6.02	6.75	9.23	9.80	7.96	92.79
EAST COAST														
Kota Bharu ..	6.08	10.19	5.46	7.00	4.61	6.41	6.09	5.22	6.59	8.71	11.96	24.04	26.25	122.83
Kuala Krai ..	5.32	12.32	4.29	7.11	4.52	6.90	6.36	6.26	7.54	9.07	11.03	15.06	19.53	110.39
Kuantan ..	3.48	15.47	8.51	8.67	6.69	6.55	5.52	5.51	5.61	7.88	10.34	13.94	22.39	117.08
Temerloh ..	3.27	7.94	3.41	6.41	7.23	6.77	4.88	3.35	5.27	6.77	9.29	9.74	9.33	80.39
Mersing ..	2.27	14.74	8.08	8.26	5.47	6.36	5.88	6.43	6.82	6.13	9.40	13.53	20.23	111.33
Kota Tinggi ..	1.44	15.33	5.72	9.35	9.77	10.37	9.51	6.00	8.06	8.63	11.63	11.75	11.88	118.00
Johore Bharu ..	1.28	11.19	7.80	11.13	11.81	9.13	6.92	6.25	7.39	8.73	8.80	10.51	10.20	110.84
HIGHLANDS														
Fraser's Hill .. (4,268 ft.)	3.43	12.76	6.78	10.17	11.47	8.02	5.05	3.47	4.92	6.93	11.89	13.04	12.28	106.78
Cameron Highlands .. (4,750 ft.)	4.28	6.33	4.61	8.19	11.67	9.33	5.59	3.58	7.23	9.24	13.57	11.96	8.78	100.29

Mean Minimum Relative Humidity (10 Years).

(Percentage)

Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Alor Star ..	52.7	43.9	47.2	58.3	63.5	63.7	63.5	64.3	66.3	65.9	65.4	59.9
Kuala Lumpur ..	54.8	48.6	52.0	57.7	58.5	56.5	55.7	54.9	57.5	59.6	59.5	57.7
Malacca ..	60.9	54.4	51.7	67.1	69.2	67.6	68.5	68.8	68.5	68.3	67.8	64.7
Kota Bharu ..	67.5	62.5	61.1	59.3	58.6	59.4	60.0	59.5	59.9	64.9	70.2	70.7
Temerloh ..	63.4	53.9	59.3	55.0	57.1	57.6	56.3	54.5	54.7	58.0	52.6	53.9
Kluang ..	60.0	56.0	59.6	61.5	62.2	62.1	61.3	60.3	61.9	62.2	63.2	55.4
Mersing ..	75.9	72.4	72.8	68.8	66.7	66.1	65.2	65.2	65.0	66.4	69.9	74.4
Fraser's Hill ..	84.8	77.1	77.6	77.5	73.9	71.0	70.2	71.9	70.5	75.5	79.1	83.3
Cameron Highlands ..	69.6	62.1	66.0	69.1	68.7	65.9	65.5	68.3	68.9	71.0	73.0	71.6

Mean Sunshine (10 Years).

(Hours per day)

Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Alor Star ..	7.82	8.82	8.11	7.85	7.20	6.65	6.32	6.53	5.72	5.61	5.48	6.64
Kuala Lumpur ..	5.79	7.23	6.41	6.07	6.24	6.47	6.34	6.01	5.38	4.96	4.76	5.35
Malacca ..	6.08	7.90	6.82	6.56	6.74	6.73	6.65	6.51	5.62	5.64	5.51	5.70
Kota Bharu ..	6.15	8.19	8.02	8.38	7.45	7.11	6.75	7.35	6.28	5.66	4.91	4.75
Temerloh ..	5.19	7.12	6.45	6.52	6.52	6.36	6.35	6.56	5.81	5.22	4.74	4.68
Kluang ..	5.22	7.15	5.85	5.70	6.02	5.60	6.02	5.79	4.84	4.47	4.42	4.54
Mersing ..	5.23	7.73	6.97	6.91	7.07	6.62	6.75	6.96	5.91	5.15	4.81	4.71
Fraser's Hill ..	3.59	5 41	4.91	4.91	5.29	6.00	6.08	5.79	5.20	3.88	3.69	3.09
Cameron Highlands ..	4.32	5.90	4.92	4.63	4.91	5.42	5.12	4.80	4.06	3.61	3.56	3.61

Air Temperatures.

	Lowlands	Hill Stations
Mean monthly maxima	81.5°F. to 93.6°F.	86.6°F. (F.H., Jan.) to 75.3°F. (F.H., May).
Mean monthly minima	69°F. to 75°F.	53.8°F. (C.H., Feb.) to 63.8°F. (F.H., May).

Grass Minimum Temperatures.

	Lowlands	Hill Stations
Lowest monthly minima	55°F. (Alor Star, Feb.) to 69°F.	32°F. (C.H., Jan.) to 59°F. (F.H., April).
Highest monthly minima	73°F. (Kluang) to 79°F.	69°F. (C.H.) to 65°F. (F.H.)

Earth Temperatures at 1 ft. (Readings at 0300 G.M.T.).

	Lowlands	Hill Stations
Monthly means	78.8°F. (Mersing, Jan.) to 86.5°F. (Alor Star, April)	68.2°F. (C.H., Jan.) to 72.6°F. (F.H., April).

THE TEA MOSQUITO BUGS (*HELOPELTIS* SPP.) IN THE CAMERON HIGHLANDS

BY

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Introduction.

Assam tea has been grown commercially in the Cameron Highlands since 1926, and full details of the early plantings, with information on varieties, yields, soil types etc., are to be found in pre-war issues of this Journal (1, 2, 3) to which the interested reader is referred for details.

The total area under tea in the Highlands was 5,740 acres at the end of 1948, the yield for that year being 1,203,898 lbs. of made tea compared with 929,719 lbs. from 6,121 acres in 1947. (Data from Registrar of Statistics, Federation of Malaya).

Plantations occur from the vicinity of Ringlet (formerly spelt Renglet), at an elevation of 3,000 feet, up to a height of some 5,000 feet. The Agricultural Station at Tanah Rata, at an elevation of 4,750 feet, has 38 acres under tea of which 27 acres were plucked in 1947 and 22 acres in 1948.

The rainfall averages 100 ins. per year with an average maximum of 13.5 ins. in October and an average minimum of 3.5 ins. in July. The average temperature (half maximum + minimum) is 64.3°F. with a range from 50° at night to 70° by day (3). On 6th January 1937 a temperature of 36° (4° above freezing) was recorded. (Data from Director, Malayan Meteorological Service).

This paper deals with two species of Mirid or Capsid bugs (*Helopeltis* sp. near *cinchonae* Mann and *H. bradyi* Waterhouse), close allies of which in India and Ceylon are popularly called tea mosquito bugs or "mosquito blight." These bugs are easily the most important pests of highland tea in Malaya and, during certain favourable periods, do considerable damage which is caused by sucking sap from the leaves and shoots of the tea bushes.

Pre-war Investigations.

Pest Status.

The first Departmental reports of damage by *Helopeltis cinchonae* were for the years 1930 and 1931 (4, 5) when only minor injury was caused to young leaves. Next year, attacks occurred from time to time on young tea, and control was to be carried out by plucking when the tea came into bearing (6). By 1933 attacks were reported on young tea and on seedlings in the nursery, the latter plants being sprayed with kerosene emulsion (7). In this report by the Field Branch the insect was erroneously referred to as *H. theivora* Waterh. which occurs in India and the East Indies but not in

Malaya. The report for 1934 mentioned attacks in all areas in the Highlands but only one outbreak was serious enough to keep back development of the bushes (8); in the following year attacks were general but not serious, and reports were received that spraying with soap solution was carried out (9, 10). From 1936 to 1938 *Helopeltis* occurred on all tea estates with a small loss of crop, no serious damage, however, being noted. No mention was made of the insect during 1939.

Here is an instance of a local insect with a wide range of natural host-plants gradually becoming more important as a pest. If the figures of new plantings of Highland tea are examined the steady increase in the area under this crop will be seen. Thus *Malayan Agricultural Statistics* for 1940 give the following data:—

Year	Acreage Planted
1933	43
1934	52
1935	269
1936	336
1937	663
1938	1,125
1939	480
1940	1,327

It is now suggested that these considerable fresh plantings of tea over consecutive years could easily provide the ideal feeding conditions for *Helopeltis* to build up in order to assume pest proportions during those years.

Life Histories.

In 1939 detailed studies were begun on these bugs by the then Entomologist, Mr. N. C. E. Miller, who soon found that two different species were involved. In June and July, 1940, their life cycles were stated to be, in days, as follows:—

H. cinchonae: Egg 11, five instars 22 (4 + 3 + 4 + 4 + 7) = 33 days.
H. bradyi: Egg 7, five instars 18 (4 + 5 + 3 + 2 + 4) = 25 days.
(An instar is one of the wingless, immature stages of the developing nymphs).

Distribution and Host Plants.

The pre-war local distribution of *Helopeltis* on tea was believed to be confined to the Cameron Highlands though one of the species, later identified as *H. bradyi* Mann., had previously been taken in 1928 on plantations of gutta percha (*Palaquium gutta*) along the River Jelai, near Kuala Lipis, Pahang. Other economic host-plants besides tea recorded in the Cameron Highlands were quinine (*Cinchona succirubra* and *C. ledgeriana*), wild yam (*Dioscorea* sp.), and the cover crop *Dolichos hosei* (listed as *Vigna oligosperma*); these records appeared in an illustrated article (11) dealing largely with *Helopeltis* on cacao.

Chemical Control.

Spraying with soap solution in 1935 has already been referred to. Further experiments made in July 1940 comprised a 2 per cent. soap solution sprayed on the tea bushes and on the cover crops; dusting with pyrethrum and lime (1:2 and 1:4 respectively); and hand-collection. As this outbreak diminished of its own accord it was not possible to assess the best treatment but the rates of labour then were such that the cost of hand-collection was one-third that of dusting.

The manager at Boh Estate has recently informed the writer that in 1933 1 acre was sprayed there with tobacco and soft soap solution. Whether the kerosene emulsion said to have been sprayed on nursery seedlings on a certain estate (7) was an error is not known but it was a very drastic remedy for succulent plants.

Biological Control.

During the 1940 investigations individuals of three species of predatorial Reduviid bugs found in the Cameron Highlands were brought to Kuala Lumpur and their progeny returned for liberation in the Highlands against *Helopeltis*. These insects were *Endochus cameronicus* Miller, *Isyndus lateiventris* Dist. and *Euagoras* sp. Six Lowland species (*Sycanus leucomesus* Walk., *Isyndus heros* F., *Cosmolestes picticeps* Stal., *Euagoras plagiatus* Stal., *Rhinocoris marginellus* Thumb., and *R. fuscipes* F.) were also reared in the plains and introduced into the Highlands (12). The last reference prior to the Occupation was written in November 1941 but stated that there was no evidence that these insects had become established. This was found to hold good in 1947-48.

1947–1948 Investigations.

After the war the tea mosquito bug problem could not be tackled until October 1947. Unfortunately October, November and December are invariably very wet in the Highlands and the rainfall during these months, respectively 11.79, 9.23 and 13.87 ins., retarded the original dusting tests.

(i) Description of Both Species.

The family of Mirid (formerly Capsid) bugs in which *Helopeltis* occurs contains a large number of pests attacking apples, potatoes and currants in temperate climates and tea, cotton, cacao, kapok and sweet potato in the tropics. Four species of *Helopeltis* occur in Malaya, two, viz. *bradyi* and a species near *cinchonae*, form the subject of this paper. The third is *theobromae* Miller on cacao and annatto but taken on China tea in the plains in 1948; this is a new record, since it was searched for in vain on tea before the war (13). Finally there is the somewhat scarce *sumatranus* Roepke on gambier (*Uncaria gambier*).

The larger species, *bradyi*, was described by Waterhouse as long ago as 1886 (14), obviously from dried, shrunken and imperfect specimens, the characteristic orange-yellow thorax found in fresh females being described

as deep red, while the dark, pin-like thoracic horn is figured as ending in a flat, inclined top instead of the pale spherical knob in undried specimens. Further, Waterhouse's figures omit the two final segments of the antennae, these having clearly been broken off during transit, and finally the characteristic bluish-green colour of the sides of the basal abdominal segments is described by Waterhouse as clear yellow. The length of the female is given by him as " about 5½ mm." which measurement excludes the wings as the overall length of the insect is 7½ to 8 mm. or about one-third of an inch. The male measures 6½ mm. and when its colours are fixed has a black thorax which takes 12 to 13 days to darken from the yellow colour found in individuals which have just become adult. Consequently young males can very easily be mistaken in the field for females unless critically examined, when the absence of a sword-like ovipositor on the lower ventral surface of males will be noticed. The thread-like, dark antennae in *bradyi* are noticeably longer than the body and this serves to separate it on the bushes from *cinchonae* whose antennae are paler, shorter and end in slight swellings. (Plates I, fig. B, and Plate II, fig. E).

The first instar is hairy in both species and lacks the pin-like thoracic horn. Later instars of *bradyi* can be separated from *cinchonae* by the absence in the former of three red streaks on the abdomen. The wing-pads are not discernible in the second instar but in the third, fourth and fifth instars they respectively reach as far as the first, second and third abdominal segments. The general greenish-yellow colour is particularly noticeable in the fourth and fifth instars in *bradyi*. In both species there is a median, dorsal pore on the second abdominal segment. (Plate II, fig. D, (a)).

The smaller, but on the whole commoner local, species has been taken to be *cinchonae*, named by H. H. Mann in 1906 from specimens received from Bhutan (lying to the east of Nepal) and Assam. Mann's description (15) consists mainly of a comparison with two other species of *Helopeltis* with tables on the relative lengths of various parts of the body. In Malaya three easily observable features in the field are: the bright red colour found on the outer margin of the membranous portion of the forewing; the shorter antennae ending in a swelling; and a clear spot near the apex of the wings when folded. Less easily seen are: banded legs (which are almost uniform in colour in *bradyi*); a pale area on the thoracic horn below the swollen top; and the much shorter length of the first antennal segment. Mann, like Waterhouse, was handicapped with poor material and his figures omit the clubbed, distal antennal segment so unlike the corresponding structure in *bradyi* which has a uniform width. Throughout this paper the name *cinchonae* has been retained for convenience pending final checking of its identity, suspicion of which had been felt by the writer ever since certain discrepancies were noticed in October 1947 between the local species and Mann's description (15) of *cinchonae* from Assam and Bhutan.

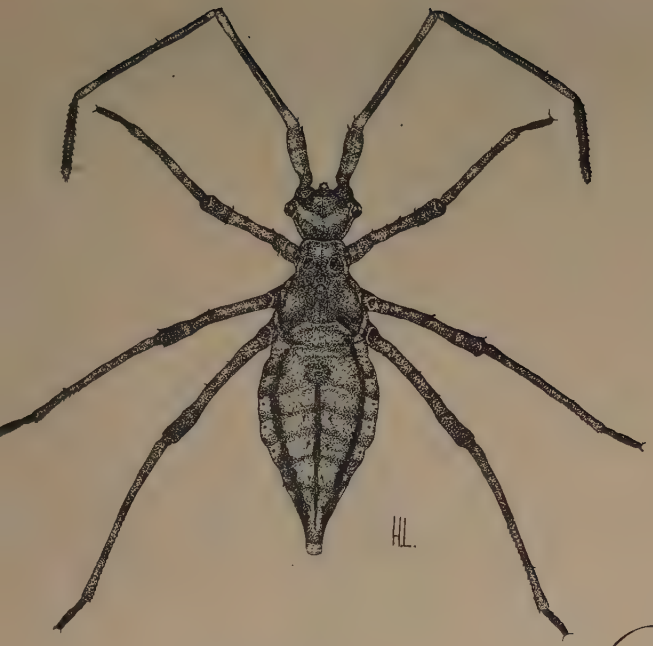


Fig. A.
Third instar. x 18.

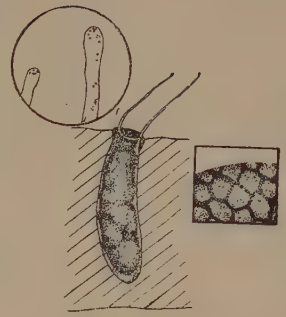


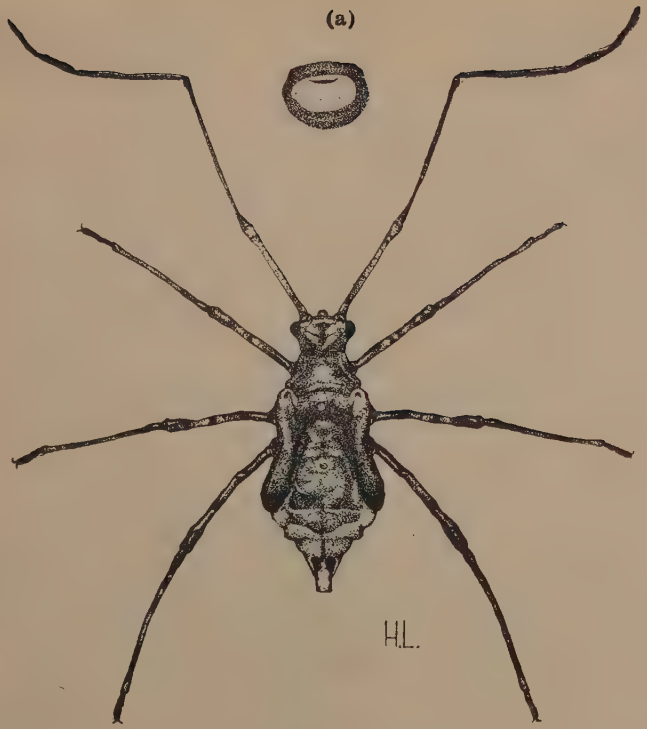
Fig. C.
Egg x 18.
Insects show tips of threads and texture.

Thoracic spine.

FEMALE

Helopeltis cinchonae Mann.

x 10.
Fig. B.



Helopeltis bradyi
(Fifth instar)
x 18
Fig. D.
(a) Dorsal pore.

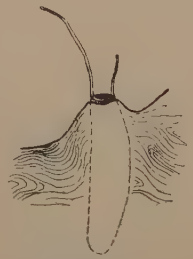
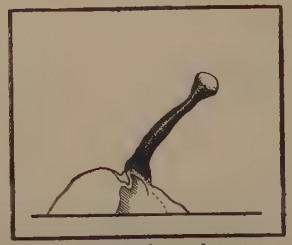


Fig. F.
Egg in leaf. x 18.



Thoracic spine.

MALE

Helopeltis bradyi Waterh

x 10.
Fig. E.

As the type specimens of this insect are not in England it is not yet possible to be sure if the identification of *cinchonae*, made in 1935 and 1937 from Malayan material returned from London, is correct.

The length of males is 5½ mm. and that of females 6½ mm.

Young stages of *cinchonae* have three red streaks (one median and two lateral) on the abdomen, these being absent in *bradyi*, a good character for field use (Plate I, fig. A, and Plate II, fig. D).

The eggs are elongate and look like miniature bananas; they measure 1.25 mm. in length (one-twentieth of an inch) exclusive of the two thread-like processes which are all that is visible of the egg which is buried in the twig or leaf-stalk. These delicate processes are approximately equal in length in *cinchonae* but in *bradyi* the process above the concave part of the egg is twice the length of that above the convex side. Near the lid or operculum a darkened, thicker portion is apparently cemented onto the egg (Plate I, fig. C, and Plate II, fig. F).

(ii) Pest Status and Damage.

Work began at Tanah Rata where the larger species, *bradyi*, was found to be much more abundant, though the reverse was the case on all tea estates visited where *cinchonae* was commoner; this held good throughout 1948. At Ringlet, (elevation 3,000 ft.), *bradyi* only has been taken.

Damage is caused primarily by the nymphs (young stages) and adults sucking the sap from the young leaves and to a lesser extent from the buds and young stalks. The result is that a series of more or less circular spots, transparent at first but gradually changing to pale brown, are left on the leaves. Later these become dark brown and eventually part or even the whole leaf shrivels and dries up from the tip or edges. Plate IV, fig. I, shows this typical damage. Some injury is also caused by the act of oviposition, the female making a slit in the young stalks prior to inserting each egg which, except for two delicate threads, is sunk below the plant tissue where it is well protected and requires practice to find in the field.

(iii) Life Histories.

Breeding of both species between October and December 1947, when the temperature averaged only 1°F. less than in June, revealed a 45 per cent. longer period than the figures for June 1940 already given. The durations of the various stages are given in Table I.

Table I.

Life Histories, October-December, 1947.

	H. cinchonae			*H. bradyi*		
			days			days
Egg	17-22,	average	19	13-16,	average	14
First instar	6-13,	„	9½	7-12,	„	9½
Second „	5- 9,	„	7	4- 8,	„	5½
Third „	6-10,	„	6½	4- 7,	„	5
Fourth „	5-10,	„	7½	5- 7,	„	5½
Fifth „	8-12,	„	9½	7- 9,	„	8½
	19 + 40	=	59	14 + 34	=	48

This 11 day difference, a matter of 20 per cent. of the whole life cycle, between two very closely related insects living under identical conditions in tea bushes, is interesting.

During the warmer months of April and May 1948 the first instar of *cinchonae* took from 6 to 8 days with an average period of only 7 days.

The duration of the incubation period of the eggs, worked out over a period of 14 months, is given in Table II with the mean of the mean maximum and minimum temperatures at Tanah Rata:—

Table II.

Incubation Period.

		H. cinchonae days	Mean Temperature	*H. bradyi* days
October	1947 ..	17—19	63.5°F.	13—14
November	„ ..	17—22	64.6	13—15
December	„ ..	17—22	64.3	13—16
May	1948 ..	16—18	65.5	9—13
June	„ ..	15—19	64.5	9—13
July	„ ..	18—19	64.3	13
August	„ ..	16—19	64.1	10—13
September	„ ..	16—21	64.1	12—14
October	„ ..	18—20	63.9	12—15
November	„ ..	16—22	63.5	13—17
December	„ ..	17—21	63.4	13—14

It will be observed that the corresponding figures for June 1940, 11 and 7 days respectively, for incubation of *cinchonae* and *bradyi* eggs are only two-thirds of the 1948 records though the difference between the mean monthly temperature for June 1940 and June 1948 was only 1.1°F.

(iv) Control by Insecticides.

(a) *Preliminary Experiments at Tanah Rata.*

Owing to the steep nature of the ground on which most of the tea is grown and the general absence of adjacent streams, the transport of water needed for spraying would be very expensive. Accordingly tests were confined to dusting, plots of 1/10th acre (containing 272 bushes) being laid out. By trial and error it was found that 5 per cent. of DDT in talc applied at the rate of 20 to 25 lbs. per acre resulted in least injury by *Helopeltis*, this being assessed by counts of leaf-spots in 10 per cent. of the test plots. Dusting with DDT was found to be more lasting in its effect than pyrethrum (derris was not available) and the resulting made tea had less taint than in the case of two benzene hexachloride formulations which were also tried. As is well known, the price of tea is largely dependent on the verdict of tasting by tea brokers.

The heavy rainfall (nearly 35 ins. fell between October and December) necessitated redusting on several occasions. Appendix B: 1 shows that the high yield of green tea in March and April, and to a lesser extent in October, is related to heavy rainfall, and the low yields in August and December/January are similarly related to the light rainfall during those months.

After these tests had been concluded, information was kindly supplied by the United Planters' Association of Southern India whose Tea Scientific Officer stated that work in the Nilgiris confirmed local results in that 5 per cent. DDT in talc was the most promising insecticide and gave no taint to the manufactured tea. Accordingly work was concentrated on finding the most economical rate at which to apply this particular dust. Owing to the irregularity of planting and the relatively small acreage of continuous pruned tea bushes then available at Tanah Rata, further work was carried out at Boh Estate.

(b) *First Dusting Test at Boh.*

In order to take advantage of the dry weather which can usually be counted upon in February, an entirely new method of testing was proposed in which the leaves from 4 blocks (each block consisting of 7 plots of 30 bushes and one undusted control plot) were to be plucked immediately before dusting, the leaves per plot being weighed separately on arrival in the factory in numbered baskets, separated into attacked and unattacked shoots (one leaf-spot damaged by *Helopeltis* being regarded as damaged) and the shoots in these two categories then weighed and counted. The dustings were to be done at 10 day intervals (the normal estate interval for plucking) at the rate of 20, 40 and 60 lbs. per acre. As 30 bushes are approximately equivalent to 1/100th acre this entailed dusting with hand dusters at the rate of 0.2, 0.4 and 0.6 lbs. per plot and therefore required careful weighing and strict supervision during application to the marked-out plots.

The residual effect of the DDT that was hoped for did not occur as although there was an increase in the ratio of unattacked shoots just after dusting ceased, this rise was not maintained in the next plucking round. Table III gives the average of the shoot counts by numbers and by weights.

Table III.

Ratio of Unattacked/Attacked Shoots.

Period	Controls	20 lbs.	40 lbs.	60 lbs.
Final dusting ..	0.74:1	2.5:1	2.65:1	5.2:1
Ten days after dusting ..	1:1	5:1	7.7 :1	12.15:1
Twenty days after dusting ..	0.69:1	1.9:1	4.25:1	2.75:1

However, the undusted controls showed a steady increase of attacked leaves for a period of ten weeks, the rates falling from 1:1 immediately after dusting to 0.2:1 one month after and 0.11:1 two months after the final dusting. Hence during the course of this tests, there was a natural increase in the abundance of *Helopeltis* throughout the experimental area. The yield from this field in March was nearly twice that for April though the rainfall was nearly equal (Appendix B: 2). June was very dry and though at Boh there was a heavy yield, Tanah Rata had considerably less plucked leaf than in May (Appendix B: 1).

These same periodic and local fluctuations in numbers have been studied in northern and southern India and in the East Indies but are not

yet understood. Some information is given later under Field Observations, (Section V), but here it is only necessary to stress that this marked variation in abundance does occur and greatly interferes with insecticidal experiments which may be complicated by a severe natural increase or decrease in the insect's numbers taking place during the course of the test.

Early in June, three months after dusting had ended, the results in the DDT-dusted plots were so little better than the undusted controls that it was decided to cease plucking and draw up a new lay-out incorporating what had been learnt.

(c) *Second Dusting Test at Boh.*

Dusting in this experiment was by means of knapsack and rotary dusters employed in large areas so as to avoid the application of minute amounts of dust per plot which would require very careful supervision in the field after weighing out.

This test began in July, normally the driest month in the year, and involved four applications at 10 day intervals of 5 per cent. DDT dust. Four 1-acre blocks were employed, one block receiving 30 lbs. per acre, another 50 lbs., and two control blocks remaining undusted. Each of these blocks was divided into three equal strips, each strip having two marked-out plots of 16 bushes per plot from which the plucked leaves were, as in the first test, collected in numbered bags and taken to the factory for examination. The system of recording adopted this time was to divide the leaves into low, medium, and high categories of damage according to whether the leaf-spots respectively numbered 0 to 5, 6 to 11 or 12 and more spots per leaf. The leaves were then counted, weighed and entered separately for each of the 24 plots. By this means a single leaf-spot did not carry as much weight for record purposes as very heavy leaf-spotting.

These records were taken for four months over steep boulder-strewn ground which was then the only locality available with sufficiently uniform heavy *Helopeltis* damage. Plate IV, fig. 2, shows dusting in progress in this area. Unfortunately during the author's absence in the plains the final dusting in two blocks was by mistake done with a mixture of DDT and sodium arsenite which scorched a number of bushes in both the dusted areas but records were taken only from the unscorched bushes and as there was a large flush, the amount of leaf handled was greater than usual. The ratios of the numbers of lightly to heavily damaged leaves are given in Table IV from the plucking prior to dusting, during the dustings and at 4, 8 and 12 weeks intervals after dusting had ceased.

Table IV.

Ratio of Lightly to Heavily Attacked Leaves.

	2 Controls (average)	30 lbs. p. acre	50 lbs. p. acre
Predust	2.3:1	2.5:1	1.9:1
1st dusting	2.3:1	5.5:1	10.5:1
2nd „	4.3:1	11.4:1	53.7:1
3rd „	4.1:1	28.1:1	70.6:1
4 weeks after dusting ..	5.2:1	43.9:1	143.9:1
8 „ „ „ ..	19.7:1	60:1	94.2:1
12 „ „ „ ..	19.2:1	34.3:1	60.8:1

Although these figures show a better residual effect by the DDT than in the first dusting (this being largely due to the changed system of enumeration), yet the eightfold steady decrease in " light " damage in the two undusted control-acre blocks shows that during the course of the test a natural decrease occurred in the number of *Helopeltis* quite irrespective of the insecticide applied. The 50 lbs. rate is regarded as being the minimum needed for heavy attacks.

In order to get definite results from these field tests it is clearly necessary to dust larger areas, probably not less than 5 to 10 acres at a time, during which the *Helopeltis* population is remaining more or less stable. If small areas are dusted, re-invasion of insects from outside the treated areas will occur which will mask the results.

It was noticed early in this work that *Helopeltis* tends to occur in isolated patches or " pockets ", to be referred to in more detail in the next section, and these small areas are adequately dusted as soon as they are noticed. For such areas hand dusters, made locally for $2, have been found satisfactory. A cigarette tin has the bottom removed and a 1 in. long tube soldered into a hole 1/3 in. in diameter cut in the centre of the lid. On to this tube is fastened a 2 ins. long funnel of wire gauze closed at the top. The lid is slit at two opposite points; these slits fit over two studs below the upper rim of the tin forming a bayonet mounting; around the lower rim of the tin is fastened 4 ins. of rubber tubing itself attached to a 6 ins. wooden handle. On the upper surface of this is fastened an 8 ins. length of spring steel whose other end is rivetted onto the tin. By slight movements of the wrist a good cloud of dust is given off through the central hole.

Owing to the steep nature of the ground it was found that it took four men, each with a knapsack duster of the " Torpille " double-acting bellows type, 2 hours to cover 1 acre with one man to assist in carrying the dust.

(d) *Tests with Diluted Insecticides.*

Experiments were made, on a laboratory scale, to cut down the strength of DDT from the 5 per cent. usually used. Tests showed that deaths of nymphs and adults occurred in 3 to 5 hours with 5 per cent. DDT, 5 to 7 hours with 2 per cent., and 8 to 9 hours with 1 per cent. However, as the field results with 5 per cent. did not demonstrate the residual effects desired, field trials with the lower concentrations were not made but 2½ per cent. seems worth trying owing to the lower cost.

In these tests it was found necessary to record 'collapse' rather than 'death' as feeble antennal and leg movements occurred for some hours after these insects had slumped and were incapable of forward movement. In no case was there ever any recovery after the moribund period set in; feeding had invariably ceased before collapse so that the insects were then as good as dead from the tea planter's point of view. Usually, but not always, the fourth and fifth instars collapsed after the adults.

(v) Field Observations.

A selection is given of a number of notes made in the field on the habits of *Helopeltis*.

Leaf-spots.—Typically a leaf-spot caused by an adult starts as a pale green or pellucid area more or less circular in shape and bordered with a brown ring and 2 to 3.5 mm. in diameter. It takes some 10 to 15 seconds after the proboscis is withdrawn before the spot is visible and it gradually becomes more and more defined until the characteristic ring appears in 10 to 15 minutes.

In a description of leaf-spots in Nyasaland mention is made (16) of the presence of a dark brown central spot where the proboscis has been withdrawn but this was rarely seen in Malaya even when the leaf was held up to the light. Recently-made feeding marks on the bushes can easily be distinguished from those several days old by their much fresher condition and pale colour. Subsequently the spots join and the leaf shrivels and dries. Feeding along the midrib of the leaves or on unopened buds results in a series of wedge-shaped blemishes often in contact so as to form a pattern. As one would expect, leaf-spots caused by nymphs are small, those of young ones being minute dots.

Feeding.—This is most usual, in all stages of both species, early in the morning and after 5.30 p.m. However, even at noon on bright days feeding has been seen but it is noticeably less after 9 a.m., especially in sunny weather. Feeding has been timed to last up to 7½ minutes in one spot before moving on to begin again, sometimes in 10 seconds; 4 to 5 minutes is a more usual period for *bradyi* and 3 to 4 minutes for *cinchonae*.

As a rule the nymphs feed in the centre of the bush, the adults on top and towards the end of the twigs. The temperature in the interior of tea bushes was recorded from November 1947 till February 1948 and is given in Appendix A: 3. The flight of adults is slow and is doubtless aided by wind currents.

As already mentioned, *Helopeltis* tends to occur in fairly static patches or 'pockets' against which control by early dusting is recommended. No particular jat of Assam tea was found to be particularly attractive or unattractive, and feeding was also found on a China jat at Tanah Rata. A survey was made in March 1948 at Boh showing the distribution of the two species and when this was checked in November those areas which were most severely attacked in March were found to be so again eight months later. Also, those fields with one species predominating were seen to maintain this distribution at both surveys.

Abundance.—This problem of great interest has been referred to previously and attempts have been made both in Malaya and elsewhere to relate it to climate, soil types, soil drainage, tea jats (varieties), shade and nearness of jungle. The survey mentioned above showed that there was no appreciable invasion into the tea from those areas abutting on jungle but there was heavy

concentration around some patches of secondary jungle in the planted areas. As a general rule, *Helopeltis* is seen to thrive best in dull, overcast weather with frequent mists, being less active in feeding and egg-laying in times of continued heavy rainfall, windy weather and bright sunshine. It is a matter of difficulty to count the number of insects of all stages in single bushes owing to the minute size of the young nymphs and their habit of running down the twigs into the centre of the bushes or crawling onto the lower surface of the leaves when disturbed; adults tend to drop towards the ground, take cover under the leaves or fly away. In this connexion it is interesting to record the much more rapid flight of *H. theobromae* on tea in the plains than either of the two Highland species. It is very clear that as few as two or three nymphs per bush can do a great deal of damage, especially in the latter instars, and this has been recorded also for an African species on cotton where only 1.5 insects per plant may result in practically no crop (17). Hence thorough dusting or spraying is required in order to check the damage successfully.

(vi) Biology.

Under this heading are grouped some observations made in the laboratory during the course of this study. Adult insects, kept for 24 hours in a tube with fresh shoots, gave the following number of punctures:—

H. bradyi —minimum 33, maximum 92, average 68.7.

H. cinchonae— ,, 89, ,, 133, ,, 114.5.

In both species, females always made many more punctures than the males. Feeding was observed to be intense from 7 till 9 p.m. and was noticed at 11.45 p.m. With these numbers of leaf-spots formed, it can readily be appreciated that one or two, let alone two or three, insects per bush can cause a great deal of loss of sap, showing how important it is to get a thorough cover on the bushes by dusting in order to reduce the population, when it is light, to a very low level.

Egg-laying was timed on several occasions and varied from 2½ to 4 minutes, the female always facing towards the thicker end of the leaf-stalk i.e. with the ovipositor towards the tip of the leaf or younger shoots. Both species squat in a more erect position when the ovipositor is inside the shoot than depicted in Leefman's figure of *H. antonii* (18).

The number of eggs laid was observed for 9 weeks, a female *bradyi* laying 25 eggs in 63 days since capture in the field and a *cinchonae* female 32 eggs in 66 days; in both species the final week before death was usually eggless. The maximum number of eggs laid in 24 hours was 9 for *bradyi* and 6 for *cinchonae*. In field collections the average number of eggs found per shoot was 2.2. Dissections of 13 females of both species showed 9 to 17 eggs, with an average of 14.2 for *bradyi* and only 2 to 8 eggs with an average of 4.3 eggs for *cinchonae*.

Copulation was observed to last at least 2 hours 10 minutes which agrees well with observation on a Tanganyika species where about 2 to 3

hours has been recorded (19). Females were seen several times to pair twice and this number is probably exceeded.

The sex ratio, worked out from insects collected in the field in two localities at three different times of the year, was found to be as shown in Table VI.

Table VI.
Sex Ratios.

				Males per cent.	Females per cent.
Tanah Rata,	January	1948	*bradyi*	36	64
Boh,	April/May	„	„	33	67
Boh,	June	„	„	32	68
			Average	33.7	66.3
Tanah Rata,	January	1948	*cinchonae*	63	37
Boh,	April/May	„	„	62.5	37.5
Boh,	June	„	„	62	38
			Average	62.5	37.5

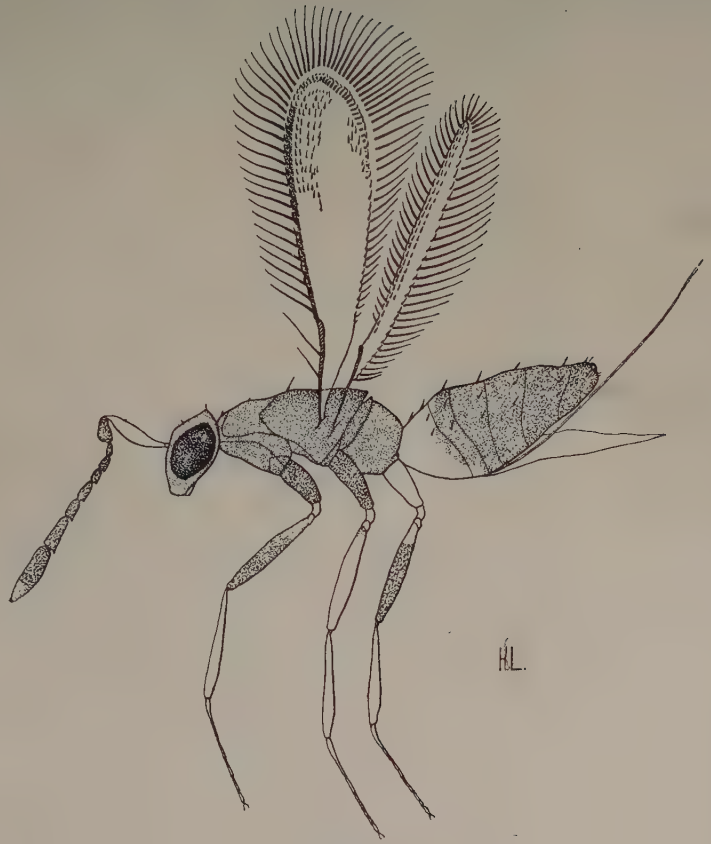
Hence one gets the quite unexpected result that of two species of the same genus of insect feeding together on the same plant while both agree in having one sex twice as numerous as the other, yet in one species (*bradyi*) it is the female, and in the other (*cinchonae*) it is the male which predominates.

Two habits of the latter species noticed in the field were firstly the adoption of a crouching position when at rest on a leaf, the antennae being held backwards and the legs retracted so that the shape of the insect is completely altered. Secondly, during feeding the hind legs are often raised on to the upper surface of the forewings which are patted or stroked. In both species the nymphs bend forward the tip of the abdomen so that it is curled over the back. They are also able to protrude the posterior portion of the rectum from which beads of moisture are expelled at intervals. Certain American members of the family Miridae (not *Helopeltis*) actually use this part of the rectum as a suction disc when dropping from one twig to another but this was not observed in Malaya.

Finally, reference is made to the interesting pin-like thoracic horn or spine arising vertically in front of the bases of the wings. Experiments were made in which this structure was snipped off with fine scissors at three levels, viz. just below the swollen tip; in the centre; and above the base. Two out of four *bradyi* (chosen on account of its slightly larger size) died at once, while two lived for 48 hours after treatment and fed normally; death was probably expedited in the inevitable handling prior to and during amputation. Microscopic examination of the severed spine showed it to be a solid prolongation of the exoskeleton with no visible sense-organs or pores. The spines are figured in insects, Plate I, B and II.

Reference has been made previously to early descriptions of this structure in which it was described and figured as ending in a cup, one author, after stating it had no duct (20), still suggested it might be "in some way a sense organ."

PLATE III.



x 65.
Fig. G.
Female.

Erythremelus helopeltidis Gahan.

x 65.
Fig. H.
Male.

Fig. 1.

Damage to tea shoots by *Helopeltis cinchonae* Mann at Cameron Highlands.
(Pencil is 6 inches in length).

Fig. 2.

Knapsack and Rotary dusters in use. Note large boulders and steep slope.

(vii) Parasites.

Soon after work began a fringe-winged parasite wasp of the family Mymaridae was bred from eggs of *cinchonae* at Boh and subsequently found at Sungei Palas, Blue Valley, Ayer Tawar and Tanah Rata. This turned out to be a new species of *Erythmelus*; the writer is indebted to Mr. Muesebeck of the U.S. Bureau of Entomology and Plant Quarantine for kindly having had this insect generically determined for him; the specific description is due this year.*

I am informed by Dr. J. Van der Vecht of the Institute for Plant Diseases, Buitenzorg, that an apparently identical parasite was bred from eggs of *Helopeltis* in the mountains of western Java in 1948. The writer sent by air a consignment of parasitised eggs from the Cameron Highlands to Java in January of that year.

The genus *Erythmelus* was erected in 1908 for an insect found in England (21) and except for references to its occurrence inside eggs of other Mirids in the Ukraine in 1929 and in the U.S.A. in 1936, no other references to economic species have been seen.

In the female the antennae are 8-jointed and end in a club while those of the male are 13 in number and are not swollen at the tip. Plate III, Figs. G and H). The overall body length is 1/25 in.

Eggs of *cinchonae* were placed with fertilised female parasites; development within the eggs was found to occupy 26 days in May 1948 with a mean temperature of 65.6°F., 32 days in September (64.0°), and took no less than 42 days in November with a mean of 63.5°, a surprising increase for such a slight difference in temperature. Figures obtained in the previous November and December averaged from 37 to 41 days for development. Eggs retained in Kuala Lumpur during December 1948 (mean temperature 81.3°F.) took only 20 to 28 days before emergence of the parasite.

When attempts were made to evaluate the percentage parasitism of insects collected from shoots in the field it was found that there was a very high degree of infertile *Helopeltis* eggs varying from 38.9 to 56.6 per cent. with an average of 50.8 per cent. (By infertile is meant eggs which did not give rise either to egg parasites or to nymphs of *Helopeltis*). These figures were made from monthly collections of eggs averaging about 850 per month. An average parasitism from fertile eggs was 36 per cent. and the total parasitism of all eggs was 17.6 per cent.

These figures would probably suggest to the tea planter that biological control was the best way to check *Helopeltis* but it has already been shown that a very high kill must be obtained owing to the damage done by only a few surviving insects. This local indigenous parasite cannot be expected by itself to wipe out the pest, for if the parasite by itself were an efficient means of control it would have done so in a state of nature, but it does nevertheless exert a considerable check in the field.

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* Since the above was written, the writer has been informed by Mr. Muesebeck that this Mymarid has been described as *Erythmelus helopeltidis* Gahan. The description is published in *Proc. Ent. Soc., Washington*, Vol. 51, No. 1, p. 75, 1949.

During egg-laying the female *Erythmelus* flexes the antennae and vibrates the tips above the bent portion. Oviposition occurs between the two strands of the egg and takes from 2½ to nearly 7 minutes. Exploratory thrusts of the ovipositor are frequently made for periods of from ¼ minute to 2 minutes but it seems unlikely that eggs are actually laid during these briefer periods.

Although taken in the field only from *cinchonae* eggs the parasites were found to lay in those of *bradyi* and develop normally therein.

Two other parasites of negligible importance have been taken in the course of the work, viz. another egg parasite which is very scarce; and, on two occasions only, an Ichneumonoid parasite, one from the fifth instar and the other from an adult female *bradyi*, neither of which, however, matured into adults.

(viii) Host Plants and Distribution.

The recorded pre-war distribution in Malaya, on tea and cinchona in the Highlands and on gutta percha along the River Jelai, was dealt with earlier. The total number of plants on which *cinchonae* has been taken is now 60 and includes herbs, creepers, shrubs and trees, a palm and one fern. The bulk of these plants were kindly identified by Mr. R. E. Holttum, Director of Gardens, Singapore. Economic plants are *Coffea arabica*, *Passiflora laurifolia* (wild passion fruit, water lemon or Jamaica honeysuckle), *Passiflora edulis* (passion fruit), *Capsicum annuum* (chillies), *Ipomoea batatas* (sweet potato), two species of *Dioscorea* (wild yams), *Solanum nigrum* (terong meranti), three other species of *Solanum* and *Cyphomandra betacea* (tree tomato). Weeds attacked include *Mikania scandens* (mile-a-minute), *Bidens pilosa* (blackjack) and two species of *Erechtites* (fireweed), besides the Singapore or Straits rhododendron, *Melastoma malabathricum*. Of general interest are the ornamental *Begonia semperflorens*, a close relation of the toddy palm (*Caryota* sp.) and the fern *Diplazium tomentosum*. Except, however, for tea none of the alternative host plants are economically injured but the wide range selected shows its possibilities as a pest on these crops, several of which have been recorded as attractive to the Java species (18).

These are all hosts of *cinchonae*, since *bradyi* has been taken in Malaya only from tea, cinchona and gutta percha.

With regard to distribution, the local range was extended to include Maxwell's Hill, where *cinchonae* was found on an unknown jungle plant in April 1947, and to Fraser's Hill on two trees and a creeper in November 1948. In both cases these new locality records were at altitudes of 3,500 to 4,000 ft.

The overseas distribution is Java for both species plus Assam and Bhutan for *cinchonae*, an exceptionally wide range for an insect with the habits and life history it has.

Summary.

An account is given of the appearance, life history and habits of two

species of Mirid bugs, *Helopeltis bradyi* Waterhouse and *H. cinchonae* Mann (or a closely related species). The former takes 7 weeks and the latter 8½ weeks to complete its life cycle, incubation of the eggs lasting 14 days for *bradyi* and 19 days for *cinchonae*. Feeding takes place on young leaves and shoots of the tea bush in the Cameron Highlands in the shoots of which the eggs are laid. Damage is most severe in dull, misty weather, the insects not favouring either heavy rain or bright sunshine. They are easily disturbed and then retire into the centre of the tea bushes or the adults take flight.

It is suggested that these local insects reached pest status during the planting of tea in the Cameron Highlands in the period 1935 to 1938.

Owing to the topography of the ground, dusting rather than spraying was decided upon for experiments in chemical control; this has been found to be the best method in the tea gardens in Southern India. Local tests indicate that three dustings of 5 per cent. DDT carried out as often as every 10 days at a rate of not less than 30 lbs. per acre checked the damage but did not give the hoped for residual effect. Dusting should be done over as large an area as possible at one time especially during the dry periods of the year (February and July in the Cameron Highlands) when the insect is at lowest numbers and the effects of the dust will be most decisive. Small pockets of the bugs should be dusted with hand dusters as soon as noticed just after plucking in those fields. In *cinchonae* the male is normally twice as numerous as the female, the reverse holding good for *bradyi*.

The eggs of the commoner, smaller species are parasitised by a small Hymenopterous parasite *Erythmelus helopeltidis* Gahan and although one-third of the eggs have been found to be thus attacked this cannot be a substitute for dusting.

Helopeltis has been taken in the jungle at both Maxwell's Hill and Fraser's Hill, it being formerly believed to be confined on tea in Malaya to the Cameron Highlands.

Acknowledgements.

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Finally, the writer would like to acknowledge the pioneer work done by the former Entomologist, Mr. N. C. E. Miller, F.R.E.S., to whom these current studies would have fallen had it not been for the accident of war.

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Appendix A.

Meteorological Data.

1. Rainfall in inches during 1948 at:—

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Boh ..	6.96	4.82	8.33	8.72	8.85	1.87	6.04	3.45	6.80	13.70	9.33	2.82	81.69 lbs.
Tanah Rata	4.19	5.69	11.50	13.03	11.71	2.71	4.72	6.62	6.40	13.77	8.77	2.20	91.31 ins.

2. Mean of mean maximum and minimum temperature at Tanah Rata (Stevenson screen), 1948:—

Jan.	Febr.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
63.5°F.	63.8	64.8	65.0	65.5	64.5	64.3	64.1	64.1	63.9	63.5	63.4

3. Temperature recorded inside a tea bush at Tanah Rata:—

	8.30 a.m.		3.30 p.m.	
	Max.	Min.	Max.	Min.
November 1947	64°F.	60°F.	66°F.	63°F.
December 1947	65	59	68	60
January 1948	60	50	70	60
February 1948	63	56	69	62

4. Means of mean maximum and minimum in Stevenson screen, at Tanah Rata:—

			Rainfall
October	1947	63.5°F.	11.79 inches.
November	1947	64.6	9.23 „
December	1947	64.3	13.87 „

Appendix B.

Yield in Relation to Rainfall.

1. Total yield in lbs. of green tea, Tanah Rata Expt. Station, 1948 and monthly rainfall in inches:—

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
4,350	4,561	7,445	7,231	5,976	5,078	5,090	4,638	4,783	6,065	5,919	4,397	65,533 lbs.
4.19	5.69	11.50	13.03	11.71	2.71	4.72	6.62	6.40	13.77	8.77	2.20	91.31 ins.

2. Yield in lbs. per acre of green tea from Field 2, Boh Estate, 1948 and monthly rainfall in inches:—

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
24	36	81	44	31	49	33	25	43	55	44	42	507 lbs.
6.96	4.82	8.33	8.72	8.85	1.87	6.04	3.45	6.80	13.70	9.33	2.82	81.69 ins.

MECHANIZATION

Quarterly Progress Report, January to March, 1949.

Compiled by the Acting Chief Field Officer.

Recent Importations and Tests.

The following new machines were received during the quarter and are now undergoing tests:—

"John Deere" power mower No. 5.
Bamford power mower for Fordson Major.
Rotary Hoe furrowing attachment and roller attachment.
Ransomes land leveller.
Fordson Power Lift spiked toothed harrow and frame.
Fordson Power Lift saddle harrow.
Brushland disc harrow.
Ransomes potato digger.
Ransomes tractor subsoiler C.8B.
Ransomes 3 furrow disc plough (Hussar).
Ditcher Cuthbertson "F".
Ditcher Cuthbertson "H".

The results of tests carried out during the quarter are as follows:—

Federal Experiment Station, Serdang.

(i) *Gravely Tractor with Hardie Spray Attachment.*

This machine has been successfully used for spraying lalang with sodium arsenite in the oil palm areas. In this spraying work, both sheet lalang and lalang in patches were encountered and the rate of work was just over 5 acres per day. The running costs, excluding cost of sodium arsenite, were $2.49 per acre. Only one spray lance was used; two can be fitted, in which case the speed of spraying would be considerably increased. The nozzle used gave an excellent spray for distances up to 30 ft., working at a pressure of 150 to 200 lbs. The rate of application was approximately 60 gallons to the acre. It was found that the steering of the machine entailed hard manual work for the operator, especially on undulating fields. It is considered that if the pump is fitted to the rear of a small track tractor, such as the Bristol or M.G.2, the work will be easier and more quickly performed. A trial is now being carried out with this pump in conjunction with the Bristol tractor.

(ii) *Farmall 'H' with McCormick-Deering Trailer Mower No. 9.*

This combination has recently been used for mowing pasture areas. In spite of uneven surfaces, a good close cut was possible, except in the early morning when it was necessary to clear the cutter bar frequently. Over a 7-day period an average of .84 acre per running hour or 5.48 acres per day was attained, the running cost per acre being $2.08. The mowing

of all pastures after grazing has been found to be very useful at Serdang for preventing the ingress of coarse grasses and small bushes which the grazing animals tend to leave untouched.

CHENDERONG BALAI, PERAK.

(i) *McConnel Trailer Model 150.*

This trailer has proved very useful for moving track-tractors along main roads. It has already been used for moving a tractor with an overall width of 8 ft 5 ins. and a weight of 6 tons 7 cwt.

(ii) *Modified T.D.14.*

An old T.D.14 tractor which has been fitted with wide, balanced 36 ins. grouser shoes has been found, in preliminary trials, to have an excellent performance on wet bog-soils. In this instance, its superiority over modified D.4 tractors is not due to a lower bearing pressure but to a higher horse power: bearing area ratio. This is shown by the figures quoted below. Work in the U.S.A. has suggested that the optimum ratio is about 1:100.

Tractor	Type	Bearing Pressure (lbs. per sq. in.)	Horse Power: Bearing Area Ratio* (D.B.H.P.: area in sq. in.)
F	T.D.14	2.97	1:120
B	D.4	2.61	1:152
C2	D.4	2.57	1:132
D	D.4	2.41	1:152

**N.B.*—These ratios are calculated from maximum theoretical draw-bar horse-powers. In practice the draw-bar horse-power is greatly reduced by wide shoes and large grousers so that all quoted ratios are likely to be over-estimates.

(iii) *D.4 grousers.*

Three types of grouser-shoes are now being tested under wet conditions:—

(I) M.S. angle iron 6 ins. x 6 ins.

(II) M.S. angle iron 6 ins. x 2 ins.

(III) M.S. angle iron 6 ins. x 2 ins. with central grousers and two hardwood shoes 2 ins. x 2¾ ins. on either side of the grouser.

With both wooden shoes fitted, the track-shoe is smooth and, in effect, has been fitted with road shoes. One or both of these wooden shoes can be removed to give extra traction. Precise comparisons have not yet been made but it would seem that type (I) is unsuitable as the digging effect is excessive; type (III) is the best under the very wettest conditions, but type (II) will probably prove better for general cultivation purposes.

KELANTAN.

(i) *Trusty Cutter Bar.*

The Trusty grass cutter, which consists of an independently driven

40 ins. cutter bar attached to the standard bogey, has been tested for the mechanical cutting of both wet and dry padi.

Manoeuvrability was such as to make the cutting of a quarter-acre field a practicable proposition, with an estimated rate of cutting of about 1 acre per hour. An inherent weakness in the clutch of the cutter bar motor gave constant trouble until three additional clutch pins and springs were fitted to make six in all. Vibration of the unit was severe enough to make the securing of bolted components uncertain, but it was found that by reducing the governed speed of the engine, reliability was much improved without affecting the rate or efficiency of cutting.

The machine appeared to be incapable of laying the cut padi in a neat swath, with all the straw at right angles to the direction of travel of the machine, and with all the ears reasonably well aligned. No modifications made to the swath board improved matters, and it was further found that the machine could not make a second circuit of the field without running over the last swath. Several labourers had to be used to remove the cut padi from the path of the machine, and even so the padi when lifted was still but poorly arranged for threshing. So long as threshing has to be done by hand, mechanical cutting with a grass mower of this type is unlikely to result in any saving of time, although were a device available which would ensure rapid and efficient threshing of mixed up straw and ears, there would perhaps be some advantage in its use.

(ii) *Lloyd Autosickle.*

This again is a machine designed for cutting long grass, but without any provision for laying the cut material in a swath. The machine was found to be most manoeuvrable but of little use for cutting padi.

Malacca.

(i) *Ransome Earth Leveller.*

This machine, pulled by a Fordson Major, has been in use at Pulau Gadong. It works satisfactorily but a Fordson is not capable of operating it at full capacity. It has therefore been slightly modified in order to carry the load with its blade almost horizontal instead of in the slightly downward direction in which it usually scrapes. If scraping is stopped when half full and the blade made horizontal, the hopper fills up completely after travelling for a few more yards. The tipping and spreading is satisfactory. When pulled by a D-4, no difficulty in operation was experienced.

(ii) *Sapper Earth Mover.*

This has been used to fill in buffalo wallows with earth brought by the Ransome leveller. For this type of light work it is satisfactory but its construction is such that it would appear to be of little use for heavier jobs. The spindle supporting the blade height-adjusting mechanism is insufficiently strong as it does not fit the lampholder socket properly. It has been replaced by a square-ended spindle which fits the socket properly.

Modifications.

CHENDERONG BALAI, PERAK.

(i) *Athey Forged-Track 6-Ton Trailer.*

This was found to be too heavy for use on bog-soils and the tracks have been removed and fitted to a light framework made from M.S. channel and meranti wood. This will be used for carting padi but has not yet been tested.

(ii) *McCormick-Deering Rice Binder.*

This has been modified as follows:—

(1) The main pneumatic-tyred wheel has been replaced by a drum-wheel 15 ins. wide and 31 ins. in diameter in order to reduce bearing pressure.

(2) The grain-wheel has been replaced by a small Orolo track with a bearing area of 175 sq. ins. (7 ins. x 25 ins.).

(3) Two small skids have been fitted in front of and behind the main wheel. The front one has since been replaced.

(4) The height-adjustment mechanism of the main-wheel has had to be strengthened.

This modified binder has shown promise under difficult conditions. The lack of any spring in the rigid main-wheel necessitated a minor modification ((4) above). It was found that tractor bearing-pressure was not a limiting factor even in very muddy places but that the binder got badly bogged in the worst patches. The small Orolo track works very well but the main drum-wheel tends to skid in soft patches and to make ruts up to 1 ft. in depth. After rain these ruts form puddles which delay resumption of work. This implement requires further modification and the main-wheel will probably have to be replaced by a track.

(iii) *McCormick-Deering Combine Harvester.*

It is planned to replace the two wheels with Orolo tracks and these are expected soon. Meanwhile an alternative modification has been carried out whereby each wheel has been replaced by a 12 ins. wide belting track-assembly made from three drum-wheels each 2 ft. in diameter and 1 ft. wide and spaced 1 ft. apart. The overall length of each track-assembly is thus 8 ft. with 6 ft. in contact with the ground. The wheels are flanged and standard 12 ins. belting covers each assembly. This design gives a very large bearing area but has been found, in practice, to complicate turning. Further modifications are in hand.

PROVINCE WELLESLEY.

(i) *New Iron " Tractor Type " Kedah Roller.*

Dimensions; length 10 ft., diameter 18 ins. The present Kedah roller is not long enough to cover wheel tracks and consequently an uneven surface is left after rolling operations are completed. This is conducive to " patchy " crops when there is a shortage of water. Also, due to the fact that it is

a very heavy implement with a diameter of only 12 ins., it is apt on soft deep soils to sink and the bow wave arising from sinkage is an added strain on the tractor engine. The new roller being lighter and 10 ft. in length will, with its greater diameter, ride more easily and should give better results.

(ii) *Drum Roller with Extensions.*

The " tractor type " Drum roller, like the Kedah roller, is insufficiently long to deal with wheel tracks and has now been lengthened to overcome this difficulty.

(iii) *Fordson Major Wheels.*

Past experience has indicated that on certain lumpy and sticky soils the P.W. solid rear wheels are apt to fill with mud, with the added weight tending to anchor the tractor and thus cause increased strain on the engine. By enclosing the rear wheels with 3/15 ins. plates, the earth does not accumulate to the same extent. The slightly increased weight will be more than balanced by added manoeuvrability in difficult areas.

(iv) *Tillmor—Extension of Enclosed Wheels.*

The present wheels are only 4 ins. wide and on soft deep land the machine is apt to sink and a bow wave is formed in front of the cultivator which aggravates the already heavy strain on the engine. With the wheels extended to 12 ins. and covered with 3/15 ins. plates the machine will tend to ride more easily and to give a better account of itself.

(v) *Gem Rotary Hoe—Reduction of Width and Enclosing of Wheels.*

The open-work wheels constructed at Bukit Merah were found to be rather troublesome when cornering in deep soft land. To increase manoeuvrability and prevent earth from clogging the wheels the width has been reduced from 12 to 9 ins. and the wheels completely enclosed with 3/15 ins. plates.

(vi) *Allen Mower—Reduction in Width and Enclosing of Wheels.*

Recent experience has indicated that the open-work wheels of the Allen mower are too heavy and that earth and weed growth tend to accumulate and anchor the machine. To eliminate this the width of the wheels has been reduced from 12 to 6 ins. and they have been enclosed with 3/15 ins. iron plates.

General.

Federal Experiment Station, Serdang.

Field-Marshall Tractor.—The statement at page 219 of Volume XXXI (October 1948) of this Journal that this tractor is difficult to start was made prior to the receipt of a supply of ignition papers for starting purposes. Since these have been received, no difficulty has been encountered in starting the machine.

Chenderong Balai, Perak.

The mechanical harvesting of padi at Chenderong Balai is in progress.

The chief agricultural difficulties which have a bearing on the mechanical harvesting of padi are as follows:—

(1) Uneven ripeness.

(2) Straw often too green—this loses strength rapidly in the stook.

(3) Stooks do not dry out rapidly after rain.

KELANTAN.

Threshing Drum.—A portable power-driven thresher has been constructed for use in the field, and has been under test. It consists of a 15 ins. diameter drum, about 4 ft. in length, mounted on a spindle, and driven by a light tractor at about 250 r.p.m. The drum carries a number of wire staples very slightly off-set one from another which exercise a combing effect on the bundle of padi held on to the drum. Breakage of the ear does not occur to any extent unless the padi is seriously over-ripe. The drum effects a great saving in physical effort but it is questionable whether costs and rate of working will show any improvement over hand-threshing methods.

INAUGURAL SESSION OF THE INTERNATIONAL RICE COMMISSION, BANGKOK, 7th to 17th MARCH, 1949.

The International Rice Commission was instituted by the Council of the F.A.O. in response to recommendations which had been made by the International Rice Study Group at Trivandrum, May-June, 1947, at the Statistical Conference in Singapore, January, 1948, and at the International Rice Meetings at Baguio, February-March, 1948. These recommendations were that international co-operation was required for the solution of many of the problems of rice production and of nutrition, and that standardisation was required of the terms used and of the manner of compilation of statistics relating to rice production and utilization.

A constitution was drawn up which defined the Commission, its membership, organisation, and functions such as:

(a) formulating and keeping under review the scientific, technical, and economic problems involved in the production, conservation, distribution, and consumption of rice;

(b) Promoting and co-ordinating research into those problems, and its application to the development and adoption of improved methods in everyday practice;

(c) undertaking, where necessary and appropriate, co-operative projects directed to the solution of the above-mentioned problems.

The Government of Siam invited the Commission to hold its inaugural session at Bangkok, in March, 1949, and the meetings of the Commission were held in the Conference Hall and the Faculty of Arts Buildings of Chulalongkorn University, Bangkok, commencing on Monday, 7th March.

The Minister of Agriculture, Government of Siam, gave an address of welcome, and the first plenary meeting was presided over by Mr. N. E. Dodd, Director-General of F.A.O. Delegations attended from Burma, Ceylon, France (Indo-China), India, Italy, Netherlands (Indonesia), Paraguay, Philippine Republic, Siam, United Kingdom and U.S.A. Observers representing Australia, China, S.C.A.P., U.N.E.S.C.O., and E.C.A.F.E. were also present.

Mr. R. B. Jagoe, Senior Botanist, Department of Agriculture, Federation of Malaya, attended this inaugural session of the Commission as an Associate of the United Kingdom delegation.

Following the inaugural plenary meetings, whose business included the election of H.S.H. Prince Sithiporn Kridakara as Chairman pro. tem., the adoption of the report of the Agenda Committee, and discussion on the Rules of Procedure, three working committees were formed to discuss different groups of problems:

Committee A, *Production*:
Chairman, Dr. Ramiah (India);
Committee B, *Distribution and Utilization*:
Chairman, Mr. L. B. Ellis (U.S.A.);
Sub-Committee, *Nutrition*:
Chairman, Dr. Dorolle (France);
Committee C, *Statistics and Terminology*:
Chairman, M. Felix Rosenfeld (France).

At the third plenary meeting on the 11th March the Report of the Committee on Rules of Procedure was approved and adopted, and Prince Sithiporn was confirmed as Chairman of the Commission for the 1949 session.

The technical committees continued their discussions for several days and presented reports for discussion, modification and adoption at the final plenary meetings on the 15th and 16th March.

The principal recommendations of these Committees were:—

A. *Production.*
(1) Collection of information on incidence and control of pests.
(2) Collection of information on mechanization and economics of mechanization of rice cultivation.
(3) Collection of information on general conditions including meteorological, cultural, social and economic factors affecting rice production in different countries.
(4) Collection of information on fertilizer practices and experimentation.
(5) To set up a work party on rice breeding to meet prior to the next Annual Meeting of the Commission.

B. *Utilization and Distribution.*
(1) Studies by engineers and nutrition workers to improve the design of rice mills.
(2) Studies on and collection of information on improved conditions of storage of rice.
(3) Standardisation of terminology of grades of rice and by-products.
(4) Improvement in the technique of parboiling, with a view to the greater popularisation of this form of rice on account of its higher milling out-turn and greater nutritional value.
(5) Exploration of the possibilities of securing special funds for nutrition research.

C. *Statistics and Terminology.*
(1) All international rice statistics should be expressed in the metric system.
(2) Standardisation of terms and definitions relating to production of paddy and milling and consumption of rice.
(3) Re-examination of conversion rates at present being used.

(4) Standardisation of all forms used in presentation of statistics of production and consumption of rice.

(5) Establishment of a Statistical Advisory and Research Unit to advise and assist member Governments on methods of collection and presentation of rice statistics and on methods of crop estimates.

During discussion in the last Committee it was found necessary to distinguish between the statistics of compilation of data and the mathematical science of biometrics. The latter was referred for consideration to the next annual session of the Commission.

All the meetings were marked by the freedom and cordiality of discussion by delegates of member Governments, and by observers representing interested organisations.

The success of this first session of the International Rice Commission must now depend on the successful implementation of its recommendations by Governments concerned.

R. B. J.

Abstract.

RECOMMENDATIONS FOR THE ORGANIZATION OF COLONIAL RESEARCH IN AGRICULTURE, ANIMAL HEALTH AND FORESTRY*

1. Introduction.

The Committee for Colonial Agricultural, Animal Health and Forestry Research was established by the Secretary of State for the Colonies for the purposes, among others, of advising on the general policy for research within the fields covered by its title, on the provision required for such research, and on the scope and functions of regional and other research institutions in the Colonial Empire.

As recently as 1945 the subject of this memorandum was reviewed by a Sub-Committee of the Colonial Advisory Council for Agriculture, Animal Health and Forestry.

Two recommendations of the Sub-Committee's report have been accepted in principle by the Secretary of State: namely, that a Colonial Research Service should be set up, and secondly, that agricultural research in the Colonies should be organized as far as possible on a regional basis. The memorandum is mainly concerned with planning the measures to carry out the second of these two points of policy.

2. General Principles in Organizing Colonial Agricultural Research.

We consider that three principles should guide us in recommending measures for the future organization of agricultural research in the Colonies:

I. That agricultural research shall be so organized and so maintained that it shall play its full part in providing the knowledge upon which agricultural improvement can be based;

II. That the organization of agricultural research shall be such that the resulting knowledge obtained flows freely to those who will apply it to practice or will convey it effectively to those who will apply it, and

III. That agricultural research shall be so organized that it is accepted as an essential and continuing activity in Colonial communities.

3. The Nature of Colonial Agricultural Research.

The tasks confronting an agricultural research service in the Colonies may be classed under three heads:

(a) Basic surveys, aiming at the better identification of the problems for detailed research and contributing to the proper assessment of the agricultural resources and potentialities of the Colonies.

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* A Report by the Committee for Colonial Agricultural, Animal Health and Forestry Research. Colonial No. 219, H.M. Stationery Office, London, 1948. Price fourpence.

(b) The solution of the problems of agriculture that come under examination by the research worker as being *prima facie* amenable to scientific investigation.

(c) Research directed to the maintenance of steady advance in those fields of application of science which are primarily related to agriculture, so that agricultural science may continually strengthen itself to deal with recognised problems of the industry, so that advantage may be taken of all fresh developments in pure science, and so that new ideas in agriculture may be stimulated.

With regard to (a), basic surveys are of great general importance as contributing knowledge essential to the proper planning of both research and development. These surveys may be considered to fall into several broad categories; e.g., surveys of inanimate resources, such as soils, water supplies, fertilizer resources, climate; of biological resources, such as plants and animals and their interactions; and socio-economic studies, such as studies of systems of peasant agriculture and of agricultural populations in relation to physical resources. We realise that many of these studies, and particularly the socio-economic studies, are the primary concern of others rather than the agricultural research worker. In the case of some, e.g., meteorology, it may suffice simply to bring the requirements of agriculture to the notice of those responsible for the collection of data. But we are convinced that an agricultural research organization must be deeply concerned in the conduct of some and in the results of all these surveys, which should form the solid basis of its research work.

The tasks considered under (b) and (c) cover a wide variety of research activities in the laboratory and in the field, ranging from straightforward applied or " technological " research through what has been termed " basic " research, occasionally to truly fundamental research. No exact division on this basis is, however, possible; and most problems will call for each kind of research for its complete solution.

5. Regional Organization of Agricultural Research.

We are impressed by the advantages of organizing agricultural research in regions wherever this is possible. Regional organization would provide for a larger and more varied body of specialists than it would be economical to employ in a single Colony. Furthermore, since many of the problems of adjacent countries are identical, they can best be solved by the concerted attack of teams regionally co-ordinated, rather than by individual officers or local teams not fully co-ordinated with others in adjacent countries.

The building up of a series of regional Research Organizations to serve the major Colonial regions cannot be other than a gradual process. There is at present a marked shortage of workers in all the sciences, and any hasty establishment of regional Research Organizations might be at the expense of quality in their staff. We consider, therefore, that any attempt to force the pace would not be in the best interest.

[The Report discusses agricultural research in East Africa and the West Indies].

Other possible regional groupings for future consideration are the West African Colonies; and Malaya, Sarawak and North Borneo. Until regional Organizations are established, and in such Colonies as do not fit into any regional grouping, we recommend that the research needs continue to be met through research branches of the individual Colonial Departments; or, where suitable, by visits of research specialists or teams, either from appropriate regional Organizations, or specially appointed for the particular purpose.

We have given much thought to the question whether there should be a single Organization embracing research in agriculture, animal health and forestry, or separate Organizations for each of these subject. We are in no doubt that the objective should be to ensure that research in the several facets of land use should proceed as a fully co-ordinated activity; and we recognise that to this end it will often be necessary that research workers in all three subjects collaborate as a team. The consolidation of all the sciences within a single Organization would ensure collaboration at all levels; and, in the view of the majority of us, this is the desirable aim. We recognise, however, that there are other factors to be considered; and consolidation may, in practice, be impossible. The objective we have stated above should be possible of achievement provided there is close collaboration between separate Organizations functioning as individual units. Where, however, separate Organizations are set up, it will be of the utmost importance to ensure that no barrier arises to hinder collaboration between the Directors and staffs of the several Organizations. An important means to the desired collaboration would be the siting of the headquarters and main laboratories of the Organizations in the closest possible proximity, so that personal consultation between all research workers, and mutual understanding and appreciation, may be facilitated.

6. Regional Consultative Machinery.

[The Report refers to the earlier expressed view that a research organization must have a certain measure of independence, but considers it equally essential that those in charge of research organizations should consult those who administer or practise agriculture. It is recommended that a standing Advisory Council for Agriculture, Animal Health and Forestry should be established in each region].

The functions of the Council would be generally to discuss and advise on agricultural policy in the region, on the needs for research arising therefrom, and the priorities to be accorded; to examine and comment on research programmes presented by the Directors of Research; to receive reports of research completed and to advise on the means for ensuring that the results of research are applied to the practice of agriculture. The Council should be entitled to invite the attention of the Secretary of State

to any matters that it might consider appropriate. It should be kept fully informed of the activities of any similar Councils that might be set up for medical, social or other sciences, and for higher education, thereby ensuring that no conflict arose in the policies advocated by each separate Council.

8. The Relation of the Regional Research Organization to Colonial Departments of Agriculture, Animal Health and Forestry.

We have already emphasized in paragraph 9 [not reproduced] the paramount necessity of co-operation between Research Organizations and Colonial Departments in the region. Each has an essential part to play in a partnership working to the single end of agricultural advancement. An effective partnership requires that each partner shall understand the other's part and shall have confidence that he will play his part.

The primary functions of a Colonial Department—the implementation of agricultural policy in its many aspects—are well understood, and the responsibility of the Departmental Director is not in doubt. But in the field of research, in its widest sense, there is an overlap of functions between a Research Organization and a Department; and it is here that a definition of responsibilities is needed if misunderstandings are not to arise.

In the first place we should say that it is implicit in our proposals that the main responsibility for the planning and execution of agricultural research should devolve on the regional Research Organizations. We feel that the principle cannot be questioned that research will proceed with the greatest economy and efficiency if it is carried out or supervised by research workers, free to devote their whole time to research, and under the direction of a man experienced in the control of research. But we are fully aware that the Departments are staffed not only with a number of specialists but with trained agriculturists, veterinarians, etc., who are qualified to contribute much to the advance of research in a variety of ways, and are often able to do so in the course of, or incidentally to, their primary departmental duties. Furthermore, the research worker will often be dependent on the departmental officer for the provision of the material for his research.

In the choice of objectives for research, the Departments have an essential part to play. In consequence of their close association with the practice of agriculture and with the producers, they will generally be the first to recognise the outstanding problems and the best equipped to judge the relative urgency of their solution. On the Departments, therefore, should rest a responsibility to ensure that the Research Organization is fully aware of these problems, and, in the light of their special knowledge, to advise on the Organization's research programmes. Conversely, and more particularly if, as we propose, the specialist officers hitherto available to the Departments for research are partly transferred into the regional Research Organization, a responsibility must rest on the Research Organization to ensure that the problems in agricultural development which the Departments bring to light are given the fullest consideration in the research programme.

The Departments would not concern themselves with the detailed planning of research, which is a matter that should rest with the Director of Research and his staff. But they should have the right, and the duty, to advise on objectives and priorities. The proposed Agricultural Councils will provide the opportunity, at an official level, for full consideration of these points.

The process of developing a typical research project passes through a number of stages. The early stages will usually constitute work that can be done only by, or under the supervision of, workers possessing specialised qualifications. A stage will ultimately be reached, however, when this no longer applies; and the project then becomes one for " technological research ", generally at an experiment station. A third stage is reached when the project becomes one for demonstration and advice to producers. Whereas the first stage is the responsibility of the Director of Research and the officers of the Research Organization, the last stage is the responsibility of the Departmental Director and his staff. The intermediate stage is essentially one for collaboration between the two authorities; and responsibility should rest with the two Directors in consultation.

A particular case of technological research, where the Research Organization and the Colonial Department are equally concerned, is that of the long-term experiment in husbandry, on agricultural systems, the use of fertilizers, the management of animals and grassland and the like. Since these experiments must usually be done on Departmental Station, executive authority over them should rest with the Director of the Department; but we consider that he should accept an especially close form of collaboration with the Research Organization in the planning, recording and interpreting of the experiments. To give the Research Organization such a form of limited responsibility for these experiments (while retaining the Departmental Director's executive authority) would ensure a continuity that a Department may often find difficult to maintain in view of the numerous other calls on its staff.

In contrast with what we have termed the " research project ", which implies a search for knowledge of a somewhat wider and more general nature, there is a type of " investigation ", which for reasons of limited, and often local, significance, and for lack of research staff, it is impossible to include in the Research Organization's programme. Such investigations will embrace agricultural and socio-economic surveys, short-term experiments in crop and animal husbandry, variety trials, the mass selection of crops (which, of necessity, will have a strictly limited and local value), and similar matters. These do not call for the direct service of the specialist research worker. They should remain the responsibility of the Departmental Director, whose freedom to embark on such work should in no way be restricted. We recommend, however, that it should be the policy of Departmental Directors to advise the Research Director of any investigations that they propose to initiate, to seek his advice on the conduct of such investiga-

tions and, perhaps most important of all, to keep him fully informed of the progress and results. For whilst we do not wish to stress unduly the need to avoid duplication of work on common problems, we feel that the Research Organization should, amongst its other functions, act as a repository for information on all research and investigations carried out in the region.

[Other sections of the Report deal with the conditions for efficient research; the form and constitution of a regional Research Organization; the relation between regional Research Organizations and commodity Research Stations; and the relation between such Organizations and Colonial institutions for higher education. The Report is dated 3rd December 1947].

Departmental

FROM THE DISTRICTS

Compiled by the Acting Chief Field Officer from Monthly Reports of State/Settlement Agricultural Officers.

December, 1948, January and February, 1949.

The Weather.

Unusually dry conditions prevailed in most parts of the country during December and January and continued during February except for the east coast region where conditions more normal to the monsoon prevailed.

Crop Reports.

PADI.

The major production areas of the north-west have suffered a serious decline in crop this season owing to the prolonged drought during the latter part of 1948. Taking Kedah as an example, of a total area of 273,204 acres planted, it is estimated that approximately 30,000 acres have produced no crop at all and a further 207,000 acres have suffered a 40 to 60 per cent. loss of crop. The overall reduction in yield in Kedah, Perlis and Province Wellesley is estimated to be in the nature of 30 to 40 per cent. of the average figures for the region.

Seldom has the value of irrigation been more effectively demonstrated than during the season now drawing to a close. The irrigated areas in Kedah and Province Wellesley and the important Krian area which lies immediately to the south have, for the most part, produced good crops.

The season as regards the remainder of the west coast padi areas has been a satisfactory one, except for late planted areas such as certain of the coastal sections in Malacca and parts of Perak.

The use of short-term strains in the Tanjong Karang-Panchang Bedena area of Selangor in countering the effects of water shortage is well established and generally successful.

In the north-east region, good crops are being reaped, and overall yields are expected to exceed those of last season.

Preliminary cultivation for the 1949-50 season is being carried out in Negri Sembilan.

The sum of $250,000 is being made available this year from Food Production funds for improvements to padi areas throughout the Federation and numerous schemes have already been put in hand.

FOODCROPS AND VEGETABLES.

The foodcrop and vegetable acreage has declined considerably, the

figure at the end of 1948 being 112,921 acres as compared with 173,268 acres at the end of 1947. The diversion of labour elsewhere, the terrorist campaign, and the drought in the north-west have all had their effect in contributing to the reduction in acreage.

RUBBER.

Prices were tending to decline towards the end of the quarter, likewise the acreage of small-holdings in tapping, while a rapid and severe wintering was also taking place.

There is as yet no serious move on the part of small-holders in the direction of replanting their older stands of rubber.

The situation as regards new planting is less clear since alienation of land for the purpose is hardly as yet under way.

The purchase of latex from groups of small-holders is in progress at several centres in Trengganu and one in Kedah.

COCONUTS.

Prices remained steady in the majority of areas and production was well maintained.

FRUIT.

The seasonal crop was a good one in most areas. Banana production is increasing in Negri Sembilan and Pahang. The pineapple short season has come to a close. Further felling and clearing of new areas for pineapple planting is being carried out in Johore.

Agricultural Stations.

Rubber.—Preparations are being made for increasing the area of nurseries for the production of approved planting material for distribution to small-holders.

Fruit.—The production of budded fruit trees is being extended to meet the demand by small-holders which still exceeds the supply.

Padi.—Results of varietal trials and cultivation and manurial experiments carried out during the 1948-49 season are now being completed, likewise those for the mechanical experiments at four centres.

Vegetables.—Some interesting work is being carried out in Kelantan involving the grafting of tomatoes on brinjal stocks. The Cameron Highlands series of experiments on imported varieties has been continued.

Cacao.—Good progress was made with the laying down of the standard cacao experiment at eight Stations to test spacing, shade and reaction to soil type.

Manila Hemp.—The laying down of a comprehensive experiment at Port Swettenham has commenced. All planting material surplus to Departmental requirements has been distributed to commercial and other interests for trial.

Livestock.—The breeding work with poultry, pigs and goats mentioned in the last article in this series has been continued. White goats of the Saanen type are evidently less popular with local goat-keepers than the darker animals such as the Toggenberg.

Miscellaneous.

Visits of cultivators from Johore to the Tanjong Karang area and other places of interest in Selangor have proved popular and without doubt serve a very useful purpose.

A Young Farmers' Club, the second of its kind, has been started at Kampong Machang, Kelantan.

DEPARTMENTAL NOTES

International Rice Commission.

Mr. R. B. Jagoe, Senior Botanist, attended the inaugural session of the International Rice Commission at Bangkok, from the 7th to 17th March, 1949, as an associate of the United Kingdom delegation.

Appointments.

Mr. O. M. Lee, Senior Lecturer, has been appointed to act as Principal, College of Agriculture, Malaya, with effect from 28th January, 1949.

Mr. E. A. Rosenquist, M.A,, Dip. Agr. Sci. (Camb.), has been appointed to be a Botanist, Department of Agriculture, Federation of Malaya, with effect from 17th December, 1948. Mr. Rosenquist arrived in Malaya on the 9th January, 1949, and assumed duty at the Federal Experiment Station, Serdang, Selangor.

Promotion.

The Right Honourable the Secretary of State for the Colonies has been pleased to approve the promotion of Mr. J. R. Curry, Agricultural Officer, Malayan Agricultural Service, to be Senior Agricultural Officer, Malayan Agricultural Service, with effect from 28th November, 1946.

Leave.

Mr. A. L. Barcroft, Agricultural Officer, returned from leave on 3rd April, 1949, and assumed duty as Agricultural Officer, Malacca.

Mr. J. R. Curry, Senior Agricultural Officer and Acting Principal, College of Agriculture, has been granted 180 days leave, in addition to voyages, with effect from 29th January, 1949.

Transfer.

Mr. D. G. Jones, Agricultural Officer, relinquished duty as Agricultural Officer, Malacca, on transfer to the post of Agricultural Officer (Research) at the Federal Experiment Station, Serdang, with effect from 8th April, 1949.

Statistical.

MARKET PRICES

January to March 1949.

Rubber.—There was not a great deal of fluctuation in the Singapore price of No. 1 R.S.S. Spot loose during January. The month opened with the price at 37¼ cents per lb. and closed at 37⅛ cents, the average being 37.23 cents per lb. In February the price declined and was down to 35¾ cents on the last day of the month, the average price for the month being 36.06 cents per lb. The price gradually improved to 38⅛ cents on the 21st March but dropped back to 37 cents on the last day of the month. The average price for March was 37.26 cents per lb.

The average prices paid in London and New York were: London, January 11.12, February 10.38 and March 11.02 pence per lb.: New York, January 19.11, February 18.51, March 19.06 cents gold per lb.

The average prices for small-holders' rubber at three centres during the first quarter of 1949 are given below in Table I.

Table I.

Average Monthly Prices Paid by Local Dealers for Small-Holders' Rubber, January-March, 1949.

(Dollars per picul of 133⅓ lbs.)

Grades	Kuala Kangsar, Perak.			Seremban Negri Sembilan.			Batu Pahat, Johore.		
	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.
Smoked Sheet ..	43.93	42.35	43.68	44.66	43.42	44.68	40.63	38.13	39.56
Unsmoked Sheet ..	34.75	34.35	35.68	37.38	36.88	37.68	37.06	35.13	36.44
Scrap ..	17.50	18.13	21.10	12.63	12.75	13.75	10.38	11.19	12.13

Transport from Batu Pahat to Singapore by lorry, excluding duty, 80 cents to $1 per picul.

Tea.—The average price in Colombo for Malayan teas, as quoted in the Colombo Brokers' Association weekly report dated 23rd April, 1949, was Rs. 1.73 per lb. The average prices of Ceylon teas were as follows, in rupees per lb.: High Grown Teas Rs. 1.79, Medium Grown Teas Rs. 1.59, Low Grown Teas Rs. 1.69.

Ceylon teas are subject to an export duty but non-Ceylon teas sold at auctions ex bond in Colombo for re-export are not subject to this duty.

The retail price of Malayan tea (Boh) continued at $2 per lb.

Palm Oil.—The majority of Malayan estate production of this commodity continues to be sold to the United Kingdom Ministry of Food. The present price payable to producers is £82 per ton f.o.b. Malayan ports. The 5 per cent. *ad valorem* Malayan export duty is for buyers account.

Derris.—The price of 5 per cent. rotenone root increased again in December and remained steady during January at $78 to $80 per picul. During February the price decreased to $74 to $76 per picul.

Rice.—The rice ration in the Federation of Malaya has been increased from 2½ to 3 katis per week for the five weeks period 4th April, 1949 to 8th May, 1949. The controlled price of rice remains unchanged at $30 per picul.

Tobacco.—There was no change in the price of cured leaf in Kelantan during the first two months of 1949. Prices per picul are as follows:—1st quality $450 to $550, 2nd quality $300 to $400, 3rd quality $170 to $270.

Table II.

Singapore Prices of Various Agricultural Products.

Product	March, 1949			February, 1949	January, 1949	Average Price 1948
	Highest	Lowest	Average	Average	Average	
	per picul $	per picul $	per picul $	per picul $	per picul $	per picul $
Copra:						
Sundried No. 1 ..	33.50	31.50	32.38	32.82	35.41	38.77
Coconut Oil ..	57.50	55.00	56.34	57.43	61.77	68.74
Coffee:						
Padang Bali No. 1	168.00	168.00	168.00	168.00	152.73	115.35
Palembang No. 1	80.00	80.00	80.00	80.00	72.55	72.19
Sourabaya No. 1	94.00	94.00	94.00	94.00	87.91	82.32
Pepper:						
Muntok White ..	274.00	233.00	254.83	225.17	210.14	181.63
Sarawak ..	273.00	232.00	253.75	222.22	209.14	180.62
Cloves:						
Indian ..	*	*	*	*	*	*
Sumatra ..	*	*	*	*	*	*
Gambier:						
Rounds No. 1 ..	*	*	*	*	*	127.22†
Sago Flour:						
Lingga ..	16.38	12.63	13.65	16.63	17.50	18.55
Tapioca Flour:						
Malayan No. 1 ..	25.00	23.00	24.36	25.00	26.23	30.48

* Not quoted.

† Average January-November.

FEDERATION OF MALAYA
PRODUCTION OF PALM OIL AND KERNELS.

(In long tons as declared by Estates)

Month	Palm Oil		Palm Kernels	
	1948	1949	1948	1949
January ..	3,821.9	3,793.0	664.1	799.9
February ..	3,659.8	4,007.0	677.9	821.4
March ..	3,567.6	4,055.6	633.0	860.1
April ..	3,598.6	3,999.3	699.4	808.3
May ..	3,076.5		597.4	
June ..	2,420.1		431.0	
July ..	3,245.5		564.9	
August ..	3,617.8		690.2	
September ..	4,283.4		827.2	
October ..	4,376.6		899.4	
November ..	4,827.2		913.6	
December ..	4,762.4		873.0	
Total ..	45,257.4		8,471.1	

In April 44 estates (planted area 81,285 acres) were in production out of a total of 49 oil palm estates (planted area 83,562 acres).

MALAYAN AGRICULTURAL EXPORTS, OCTOBER-DECEMBER, 1948.

Product	Net Exports in Tons.			
	Year 1947	Year 1948	Oct.-Dec. 1947	Oct.-Dec. 1948
Arecanuts	12,507	6,043	5,071	3,111
Coconuts fresh†‡ ..	62,873†	44,887†	6,040†	10,957†
Coconut oil‡	41,112	45,245	11,218	13,750
Copra‡	45,439*	28,625*	11,332*	586*
Copra cake	5,260*	12,176*	907*	4,428*
Gambier, all kinds ..	1,156	286	382	33
Palm kernels	5,245	6,462	1,802	1,838
Palm Oil	43,325	46,821	11,547	12,348
Pineapples, canned ..	2,611	4,073	770	450
Rubber¶	645,229¶	696,978¶	178,064¶	170,324¶
Sago,—flour	5,958	16,946*	2,754	4,964*
„ —pearl	2,404	19,084	7,998	6,683
„ —raw	6,415*	6,667*	511*	3,352*
Tapioca,—flake	52	304	19	94
„ —flour	6,490	1,999*	661	645*
„ —pearl	7,205	14,263	1,736	3,901
Derris	243	80	50	6
‡Copra equivalent ..	22,625	45,795	7,018	21,977

¶ production (Federation of Malaya). † hundreds in number. * net imports.

FEDERATION OF MALAYA PADI STATISTICS.

PADI SEASON 1948-1949.

Acreages of WET PADI harvested monthly and Estimated Yields.

State/Settlement (1)	Total Area Planted or to be Planted Acres (2)	Total to 31st January, 1949			February, 1949			Total to 28th February, 1949		
		Area Harvested Acres (3)	Per cent (3)-(2) (4)	Estimated Average Yield per acre (gantangs) (5)	Area Harvested Acres (6)	Per cent (6)-(2) (7)	Estimated Average Yield per acre (gantangs) (8)	Area Harvested Acres (9)	Per Cent (9)-(2) (10)	Estimated Average Yield per acre (gantangs) (11)
Perlis ..	43,430	14,874	34.25	225	11,655	26.83	225	26,529	61.08	225
Kedah ..	273,204	70,090	25.66	194	126,143	46.17	235	196,233	71.83	220
Kelantan ..	141,555	16,920	11.95	254	59,100	41.75	274	76,020	53.70	270
Trengganu ..	44,105	14,074	31.91	178	1,331	3.02	180	15,405	34.93	179
Penang & P. Wellesley	39,395	1,404	3.56	193	10,589	26.88	190	11,993	30.44	190
Perak ..	118,634	9,418	7.94	209	43,912	37.01	282	53,330	44.95	269
Selangor ..	48,368	—	—	—	4,942	10.22	219	4,942	10.22	219
Pahang ..	46,737	33,982	72.71	191	3,165	6.77	178	37,147	79.48	190
N. Sembilan ..	34,291	34,162	99.62	303	129	0.38	72	34,291	100.00	302
Malacca ..	31,908	17,315	54.26	228	6,778	21.24	190	24,093	75.50	218
Johore ..	20,709	*	*	*	*	*	*	*	*	*
Total ..	842,336	212,239	25.20	220	267,744	31.79	247	479,983	56.98	235

* Not available.

FEDERATION OF MALAYA PADI STATISTICS.

PADI SEASON 1948-1949.

Acreages of DRY PADI harvested monthly and Estimated Yields.

State/Settlement	Total Area Planted or to be Planted Acres	Total to 31st January, 1949			February, 1949			Total to 28th February, 1949		
		Area Harvested Acres	Per cent (3)-(2)	Estimated Average Yield per acre (gantangs)	Area Harvested Acres	Per cent (6)-(2)	Estimated Average Yield per acre (gantangs)	Area Harvested Acres	Per cent (9)-(2)	Estimated Average Yield per acre (gantangs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Perlis ..	64	64	100.00	141	—	—	—	64	100.00	141
Kedah ..	4,190	3,405	81.26	105	770	18.38	113	4,175	99.64	107
Kelantan ..	32,213	7,020	21.79	147	24,931	77.39	148	31,951	99.18	148
Trengganu ..	10,364	9,159	88.37	140	1,035	9.99	134	10,194	98.36	140
Penang & P. Wellesley	1,793†	1,457	81.26	122	253	14.11	107	1,710	95.37	120
Perak ..	9,768	6,342	64.93	101	2,715	22.79	100	9,057	92.72	100
Selangor ..	1,455	—	—	—	60	4.12	60	60	4.12	60
Pahang ..	2,724	2,084	76.51	144	429	15.75	197	2,513	92.26	153
N. Sembilan ..	23	—	—	—	—	—	—	—	—	—
Malacca ..	61	51	83.61	169	—	—	—	51	83.61	169
Johore ..	3,410	*	*	*	*	*	*	*	*	*
Total ..	66,065	29,582	44.78	129	30,193	45.70	142	59,775	90.48	136

† 83 acres—no yield.

* Not available.

FEDERATION OF MALAYA RUBBER PRODUCTION.

(In long tons, dry weight)

Month	Estates		Small-holdings (Estimated)		Total	
	1948	1949	1948	1949	1948	1949
January ..	34,668	36,397	27,321	22,240	61,989	58,637
February ..	28,529	27,593	22,121	17,045	50,650	44,638
March ..	31,888	33,616	26,549	19,917	58,437	53,533
April ..	32,724		33,684		66,408	
May ..	33,294		16,313		49,607	
June ..	33,246		27,348		60,594	
July ..	35,193		22,972		58,165	
August ..	33,727		22,875		56,602	
September ..	33,292		30,910		64,202	
October ..	34,020		16,347		50,367	
November ..	34,149		27,822		61,971	
December ..	38,177		19,809		57,986	
Total ..	402,907		294,071		696,978	
Total 1947 ..	359,865		285,364		645,229	

Small-holding production is estimated from purchases reported by dealers; prior to 1949 at was estimated from the formula: Production + imports + opening stocks = exports + consumption + closing stocks.

FEDERATION OF MALAYA

PRODUCTION OF COPRA, COCONUT OIL AND COPRA CAKE.

(in tons)

Month	Copra Production		Coconut Oil Production				Copra Cake (Poonac) Manufactured	
			Copra Treated		Coconut Oil Expressed			
	Estates 1949	Small-holdings (estimated) 1949	1948	1949	1948	1949	1948	1949
January ..	2,476	2,607	6,429	9,526	3,302	4,727	2,512	3,245
February ..	2,605	1,836	6,231	8,137	3,224	4,429	2,432	3,027
March ..	2,644	1,076	7,614	8,543	3,910	4,638	2,913	3,211
April ..			8,146		4,054		3,223	
May ..			6,225		3,124		2,446	
June ..			7,620		3,729		2,955	
July ..			7,340		3,625		2,901	
August ..			8,840		4.556		3.484	
September ..			9,972		5,266		3,730	
October ..			10,709		5,535		3,933	
November ..			9,386		5,096		3,669	
December ..			10,538		5,743		3,772	
Total ..			99,050		51,164		37,970	

Notes:—1. The above statistics are compiled and published by the Registrar of Statistics, Federation of Malaya.

2. Estate copra production and coconut oil production are as declared by estates and oil mills respectively.

3. Statistics of small-holding coconut oil production are not available.

4. Small-holding copra production for commercial purposes is estimated from the formula: imports + estate stocks (opening) + estate production + small-holding production = exports + local oil mill consumption + estate stocks (closing).

METEOROLOGICAL SUMMARY, MALAYA, DECEMBER, 1948.

Locality.	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes								Number of days								
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total	Most in a day. Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more		Total	Daily Mean	Per cent.
										ins.	m.m.	ins.								
Ipoh, Perak ..	92.0	71.5	81.7	95	69	87	74			5.15	130.8	1.61	10	8						
Port Swettenham, Selangor	89.7	72.0	80.9	94	69	86	74	84.7	84.8	7.33	186.2	2.50	15	12	2					
K. Lumpur, Selangor ..	90.7	72.0	81.3	95	70	86	75			3.66	93.0	1.05	14	10	3	8				
Sitiawan, Perak ..	89.2	71.6	80.4	92	68	83	74			7.08	179.8	1.96	13	9	1	2				
Kuantan, Pahang ..	87.0	70.1	78.5	91	65	82	74			5.88	149.4	1.28	14	3		4				
Kuala Lipis, Pahang ..	87.1	71.2	79.1	90	69	83	73	82.4	83.0	7.24	183.9	1.43	19	15		17				
Temerloh, Pahang ..	–	72.0	–	–	69	–	74			6.93	176.0	1.59	20	14		6				
Bayan Lepas, Penang ..	89.0	73.5	81.3	91	69	83	75			0.75	19.1	0.45	6	5						
Malacca ..	87.3	73.3	80.3	91	71	77	75			4.59	116.6	3.03	12	9	1		2			
Mersing, Johore ..	82.3	73.7	78.0	85	70	78	78			16.87	428.5	4.08	20	20	3		1			
Alor Star, Kedah ..	89.5	71.0	80.3	94	69	84	74			0.73	18.5	0.64	3	1						
Kota Bharu, Kelantan ..	–	71.4	–	–	68	–	76	80.7		4.71	119.6	0.87	16	11		1				
K. Trengganu, Trengganu	–	72.0	–	–	69	–	77			2.24	56.9	0.82	15	10						
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	70.4	60.9	65.7	74	58	67	63	69.7		4.81	122.2	0.64	21	17		19				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.1	54.7	63.4	77	45	68	62	66.1	68.8	2.20	55.9	0.49	16	11		3				

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, JANUARY, 1949.

Locality.	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes								Number of days								
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F	Total	Most in a day. Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more		Total	Daily Mean	Per cent.
										ins.	m.m.	ins.						hr.	hr.	
Ipoh, Perak ..	92.1	70.8	81.5	97	67	83	74			4.25	108.0	1.83	13	9	1					
Port Swettenham, Selangor	90.8	71.3	81.1	94	67	84	75	85.7	85.3	3.35	85.1	0.96	9	7	1			223.15	7.20	
K. Lumpur, Selangor ..	91.3	72.1	81.7	96	68	86	75			0.82	20.8	0.50	5	4	1	3				
Sitiawan, Perak ..	88.5	71.9	80.2	93	69	81	74	84.1		4.93	125.2	1.37	10	8	4	1		228.70	7.38	
Kuala Lipis, Pahang ..	86.1	70.0	78.1	91	66	77	72	81.8	82.9	5.08	129.0	1.17	14	14		20		177.20	5.72	
Kuantan, Pahang ..	86.3	69.6	78.0	92	66	82	72			3.81	96.8	1.11	18	14				169.15	15.46	
Temerloh, Pahang ..	–	71.1	–	–	67	–	74			4.02	102.1	1.74	20	12		5		186.35	6.01	
Bayan Lepas, Penang .	89.0	73.4	81.2	92	70	85	75			2.60	66.0	1.27	11	7	3			260.50	8.40	
Malacca ..	88.8	73.3	81.1	91	69	86	68			0.53	–	0.43	6	1			1	221.60	7.15	
Mersing, Johore ..	82.2	74.3	78.3	85	69	79	78			10.99	279.1	3.97	18	16	1		11	194.85	6.29	
Alor Star, Kedah ..	91.3	71.1	81.2	96	65	86	76			0.05	1.3	0.04	2	1						
Kota Bharu, Kelantan ..	–	72.5	–	–	68	–	76	82.4		71.6	181.9	1.78	17	12		1				
K. Trengganu, Trengganu	–	72.3	–	–	67	–	76			2.07	52.6	0.77	18	8		2	2	195.75	6.31	
HILL STATIONS																				
Fraser's Hill, Pahang 4268 ft. ..	68.9	59.6	64.3	76	56	61	63	69.5		6.51	165.4	1.25	19	16		22				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	71.3	54.7	63.0	76	46	64	60	66.2	69.0	0.91	23.1	0.23	16	7		1		177.50	5.73	

Compiled from Returns supplied by the Malayan Meteorological Service.

METEOROLOGICAL SUMMARY, MALAYA, FEBRUARY, 1949.

Locality.	Air Temperature degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day.	Number of days					Total	Daily Mean	Per cent.
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot °F	At 4 feet °F			Amt.	Precipitation .01 in or more	Precipitation .04 in or more	Thunderstorm	Fog morning obs.	Gale force 8 or more			
										ins.	m.m.	ins.						hr.	hr.	
Ipoh, Perak ..	91.2	71.9	81.5	95	69	82	74			11.90	302.3	1.95	18	15	6		1			
Port Swettenham, Selangor	88.6	72.5	80.5	94	69	79	75	85.4	85.6	3.34	84.8	0.76	16	11		2		169.25	6.04	
K. Lumpur, Selangor ..	90.0	72.3	81.1	94	69	77	75			8.31	211.1	2.21	17	16	3	2				
Sitiawan, Perak ..	87.6	72.2	79.9	90	69	83	74	83.8		6.66	169.2	1.78	16	11	2	1		163.00	5.82	
Kuala Lipis, Pahang ..	87.0	71.0	79.0	93	69	77	73	82.3	82.8	4.92	125.0	0.97	17	13	4	17				
Kuantan, Pahang ..	87.2	70.5	78.9	91	66	80	73			16.35	415.3	5.51	19	17	1	3		144.15	5.15	
Temerloh, Pahang ..	–	72.2	–	–	70	–	74			10.03	254.8	2.20	15	13		3		155.10	5.54	
Bayan Lepas, Penang ..	89.0	73.4	81.2	92	70	85	75			2.60	66.0	1.27	11	7	3			260.50	8.40	
Malacca ..	86.5	72.2	79.3	91	68	78	75			5.74	145.8	1.16	16	12				173.55	6.20	
Mersing, Johore ..	82.8	73.0	77.9	86	69	75	79			14.56	369.8	5.58	18	17	1			161.25	5.76	
Alor Star, Kedah ..	90.9	71.6	81.3	96	68	84	75			2.83	71.9	1.03	9	8				186.60	6.66	
Kota Bharu, Kelantan ..	–	73.1	–	–	70	–	78	83.6		7.09	180.1	3.61	12	10	1	2				
K. Trengganu, Trengganu	–	72.7	–	–	69	–	77			7.09	180.1	2.29	16	10		1		174.45	6.23	
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. ..	71.6	61.2	66.4	76	58	62	64	70.2		9.35	237.5	1.69	21	19		14				
Cameron Highlands, Tanah Rata, Pahang 4750 ft.	72.1	54.7	63.4	76	49	64	60	66.5	69.3	6.30	160.0	1.35	18	13		2		118.80	4.24	

Compiled from Returns supplied by the Malayan Meteorological Service.